**Echocardiographic Features of HFpEF patients with Hypertension - A Cross-Sectional Observational Study from Bangladesh**

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**Introduction**

Hypertension is one of the most common diseases in Bangladesh. Approximately 20% of the adult population and 65% in elderly suffer from this disease in Bangladesh.1 If not controlled it may lead to hypertensive heart disease, which is associated with increased morbidity and mortality.2

Various LV geometric/ chamber changes may result in asymptomatic diastolic dysfunction initially. If not controlled progress to heart failure, which maybe with preserved ejection fraction

initially and ultimately lead to reduced ejection fraction.3

Echocardiography is essential for evaluation of patients with hypertensive heart disease. Conventional echocardiographic analysis over the last decadefocuses on degree of hypertrophy of the LV, severity of diastolic dysfunction and presence of systolic dysfunction. This approach is closely linked to the idea that there is a continuum of cardiac changes in hypertensive patients and LV systolic dysfunction develops late in its natural history.4 Newer methods of assessment including 2D speckle tracking echocardiography enables quantitative assessment of LV function with high accuracy.5Speckle tracking is an innovative approach that can detect subclinical systolic dysfunction in patients with preserved ejection fraction and thus identify patients at higher risk of developing overt systolic dysfunction. If these patients can be identified before they develop irreversible systolic heart failure, aggressive therapeutic measures can be used to control hypertension halting the progression of heart failure, reducing morbidity and perhaps mortality in these patients.

The aim of this study was to evaluate different echocardiographic characteristics of hypertensive patients with heart failure with preserved ejection fraction (HFpEF) using different echocardiographic modalities.

**Materials & Methods**

This was an observational study conducted at the department of cardiology, Bangabandhu Sheikh Mujib Medical University, Dhaka from May 2018 to February 2019 after IRB approval (Protocol No. BSMMU/2018/4758). A total of 26 hypertensive patients with HFpEF diagnosed according to the 2016 European Society of Cardiology (ESC) guidelines for the diagnosis and treatment of acute and chronic heart failure were enrolled. Patients with regional wall motion abnormality in 2D echocardiography, moderate to severe valvular heart diseases, prosthetic valves, pacemakers, congenital heart diseases, Patients currently having arrhythmia such as atrial fibrillation on ECG screening during enrollment of patient were excluded from this study.

**Study Procedure**

Patients were enrolled after obtaining their written informed consent.Diagnosis of hypertension was based on 2018 ESC/ESH guidelines for management of hypertension if office SBP ≥140mmHg or DBP≥90mmHg on two or more hospital visits. Demographic data were recorded. Detailed history was taken and clinical examination was done. 12 lead ECG was done to screen for LV hypertrophy. Echocardiography was performed by using Vivid E9 (GE Healthcare, Norway). ECG leads were connected before analysis. LVEF was obtained by Simpson’s modified biplane method. The LV mass was estimated by using the area length method and adjusted for body surface area. Echocardiographic LV hypertrophy was defined as an LV mass index> 115 g/m2 for men and > 95 g/m2 for women. LV geometry was classified based on relative wall thickness (RWT), defined as (2×diastolic posterior wall thickness)/LV end-diastolic dimension and Left Ventricular Mass Index (LVMi) as recommended by the American Society of Echocardiography (ASE): normal = RWT ≤ 0.42 and no LVH; eccentric hypertrophy = RWT ≤ 0.42 and LVH; concentric remodeling = RWT > 0.42 and no LVH; concentric hypertrophy = RWT > 0.42 and LVH. Right ventricular (RV) function was assessed by tricuspid annular plane systolic excursion (TAPSE) and tricuspid lateral annular systolic velocity (S') by pulsed tissue Doppler. Peak pulmonary arterial systolic pressure (PASP) was estimated as the sum of peak RV-right atrial gradient from the tricuspid valve regurgitant jet and right atrial pressure on the basis of size and collapsibility of inferior vena cava. Presence and severity of valvular heart diseases were assessed by color Doppler imaging and image guided pulsed and continuous Doppler studies according to 2014 AHA/ACC Guidelines for the Management of Patients with Valvular Heart Disease. Patients with more than mild valvular heart diseases were excluded. Diastolic function parameters were measured as follows: peak early diastolic filling (E) and late diastolic filling (A) velocities, E/A ratio, E deceleration time, early diastolic septal and lateral mitral annular velocity (e′), average E/E′, peak TR jet velocity, left atrial volume index. Left atrial volume index was calculated using biplane area–length method from apical four and two chamber views at end-systole from the frame preceding mitral valve opening and was indexed to body surface area. Diastolic dysfunction was classified into three grades according to 2016 ASE/EACVI guidelines.

LV longitudinal strains were analyzed by 2D speckle tracking echocardiography. Cardiac cycles were obtained during a breath hold in end-expiration. Special care was taken to obtain correct view and checking for foreshortening. Endocardial border was traced at end systole, with a frame rate of 50-80/second, from apical long axis, four chambers and two-chambers view. In case of poor tracking, region of interest (ROI) was readjusted. The results of all three planes were combined in a single bull’s eye summary, along with a global longitudinal strain value (GLS) for the LV which was automatically calculated by automated function imaging (AFI). An independent investigator analyzed the echocardiography recordings blinded to clinical data.

**Statistical analysis**

After collection of all information, the data were checked, verified for consistency and edited. Data cleaning validation and analysis was performed using the software SPSS (Statistical Package for Social Science) version 24.0 for Windows. Descriptive statistics were used to summarize data using means and standard deviation. Categorical data were summarized by calculating percentages which were presented as frequency tables and charts. Frequency of subclinical systolic dysfunction in hypertensive patients with HFpEF was determined by comparing the GLS between study subjects and lower limit of normal cutoff value for vendor GE.

**Results**

A total of 26hypertensive patients with HFpEF were enrolled for this study. Majority of the cases were males with a male: female ratio of 1.6:1(Fig 1).Most study subjects were elderly between 61-70 years (53.8%). The mean age was 62.31 ± 7.95 (Fig 2).

**61.5%**

**38.5%**

**Fig 1: Distribution of study subjects according to sex**

**Fig 2: Age distribution of study subjects**

Percentage (%)

Age group (years)

Majority of the study subjects were overweight (53.8%). 26.9% patients were obese and only 19.2% patients had normal BMI (Fig 3).

**53.8%**

**26.9%**

**19.2%**

**Fig 3: BMI of study subjects**

**Clinical and electrographic characteristics**

In the present study, study subjects had multiple comorbidities. Majority of the study subjects were dyslipidemic(69.2%) and diabetic (57.7%)(Table I). Mean SBP was 148.08 ± 19.18. Mean DBP was 91.92 ± 10.96. ECG voltage criteria for LVH were present in 26.9% hypertensive HFpEF cases.

**Table I: Baseline characteristics of study subjects**

|  |  |  |
| --- | --- | --- |
| Comorbidities | Frequency (n) | Percentage (%) |
| Diabetes Mellitus | 15 | 57.7 |
| Dyslipidemia | 18 | 69.2 |
| Stable CAD | 11 | 42.3 |
| History of heart failure admission | 13 | 50.0 |
| Paroxysmal AF | 2 | 7.7 |
| CKD | 10 | 38.5 |
| Smoking | 9 | 34.5 |

**Table II: Blood pressure and pulse of study subjects**

|  |  |
| --- | --- |
| Variable | Mean ± SD |
| Systolic BP (mmHg) | 148.08 ± 19.18 |
| Diastolic BP (mmHg) | 91.92 ± 10.96 |
| Pulse ( beats/minute) | 96.69 ± 10.56 |

**Table III: Subjects with ECG voltage criteria of LVH**

|  |  |
| --- | --- |
| ECG- LVH | n (%) |
| Negative | 19(73.1) |
| Positive | 7(26.9) |

**Table IV: Echocardiographic findings**

|  |  |  |
| --- | --- | --- |
| Parameter | Mean ± SD | |
| **LV structure** |  |
| LV mass index (g/m2) | 92.30 ± 22.37 |
| RWT (cm) | 0.42 ± 0.12 |
| **LV systolic function** |  |
| LVEF (%) | 61.27 ± 6.09 |
| GLS (%) | -16.74 ± 3.41 |
| **LV diastolic function** |  |
| E/A ratio | 1.19 ± 0.75 |
| Average E/E' | 15.54 ± 3.55 |
| LAVi (ml/m2) | 40.51 ± 4.70 |
| TR jet velocity | 2.73 ± 0.58 |
| **Pulmonary and RV function** |  |
| PASP (mmHg) | 38.89 ± 11.42 |
| TAPSE (mm) | 19..00 ± 2.51 |
| S’(mm) | 12.11 ± 2.43 |

**Conventional echocardiography and Doppler tissue imaging**

Normal LV geometry was found in majority of HFpEF cases, (38.5%) patients. Concentric LV hypertrophy was present in (30.8%) of participants, whereas Concentric remodeling was found in (23.1%) of cases, and (7.7%) of patients had eccentric hypertrophy (Fig 4).The mean LVEF was 61.27 ± 6.09. The mean of LAVi was 40.51 ± 4.70. The mean LA diameter and average E/e′ was also elevated. RV systolic function was normal as evidenced by normal TAPSE and S’ (Table IV). All HFpEF cases had some form of diastolic dysfunction. 23.1% patients had Grade I diastolic dysfunction. 57.7% patients had grade II diastolic dysfunction and 19.2% cases had grade III diastolic dysfunction (Fig 5).

**38.5%**

**23.1%**

**30.8%**

**7.7%**

**Fig 4: LV geometry of study subjects**

**23.1%**

**57.7%**

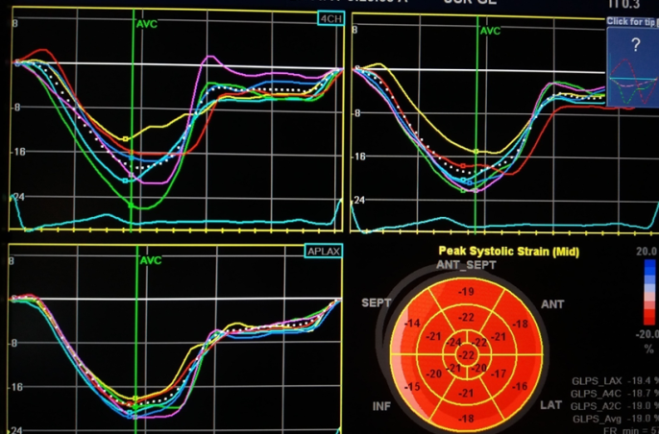
**19.2%**

**Fig 5: Grade of diastolic dysfunction in study subjects**

**2D Speckle tracking echocardiography**

The mean value of GLS in hypertensive cases with HFpEF wassignificantly reduced to -16.74% ± 3.41. About two thirds (65.4%) of study subjects had reduced GLS when -18% was used as the cutoff value for lower limit of GLS in normal population (Table V).

**Table V: Frequency of subclinical systolic dysfunction in study subjects**

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**Fig 6: GLS obtained from 2D speckle tracking echocardiography**

**Conclusion:**

In the present study impaired global longitudinal strain was detected by a significant reduction of LV GLS in65.4% when subclinical LV dysfunction was defined as 2D derived GLS less negative than -18% as per vendor recommendations for GE.16The findings of this study is similar to the study by Kraigher-Krainer et al. (2014) which showed lower LV longitudinal strain despite preserved LVEF in 66.7% patients with HFpEF.13Imbalzano et al.(2011) also revealed that 2D-STE showed an impairment of systolic longitudinal strain in majority of hypertensive patients including those without LVH.17

The documentation of subclinical systolic dysfunction in hypertensive patients with preserved ejection fraction is an important observation for better control of BP and close monitoring in these high risk patients for prevention or progression of hypertensive heart disease. Assessment of different echocardiographic parametersidentified a series of early changes. Aggressive management of these patients with high risk findings could have significant impact in prognosis of these patients. For confirmation further large scale randomized controlled trials are required.

**Limitations**

This was a single center study with small sample size. This study was done on hospital based patient population therefore may have selection biases.