Section: Physiology

Original Research Article

AN ECHOCARDIOGRAPHIC STUDY OF THE EFFECT OF OBESITY ON SYSTOLIC AND DIASTOLIC FUNCTIONS OF THE LEFT VENTRICLE IN HYPERTENSIVE ADULTS

Received : 18/12/2022
Received in revised form : 11/01/2023
Accepted : 04/02/2023

Keywords:
LV diastolic dysfunction, overweight, obesity, hypertension, heart failure.

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DOI: 10.47009/jamp.2023.5.2.1

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2023; 5 (2); 1-4

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Abstract

Background: The impairment in left ventricular relaxation is one of the effects of obesity on left ventricular function, regardless of the existence of other comorbidities. Chronic hypertension is the most common cause of diastolic dysfunction and failure. Present study was aimed for echocardiographic study of the effect of obesity on systolic and diastolic functions of the left ventricle in hypertensive adults. **Material and Methods:** Present study was comparative, observational study, conducted in cases as patients of 40-60 years age, of either gender, had hypertension for more than 2 years, had raised body mass index (BMI > 25 Kg/m2). Control group was of patients of 40-60 years age, of either gender, had hypertension for more than 2 years, had normal body mass index (BMI 19 - 25 Kg/m2). **Results:** In present study, 50 cases & 50 controls were studied. Mean age, gender, systolic Blood Pressure & diastolic Blood Pressure were comparable among cases & controls, difference was not significant statistically (p>0.05). Mean weight & BMI was significantly higher among cases as compared to controls & difference was statistically significant (p<0.05). Normal diastolic function was seen in 18 % of cases & among 64 % of controls. Among cases diastolic dysfunction was found from grade I (34 %), grade II (24 %), grade III (16 %) & grade IV (4 %). Among controls diastolic dysfunction was found from grade I (20 %), grade II (12 %), grade III (4 %) & none had grade IV. Among cases, diastolic function was worse. Grade III and IV dysfunction was significantly higher compared to controls & difference was statistically significant (p<0.05). **Conclusion:** LV diastolic dysfunction was common in overweight/obesity individuals with hypertension and had risk of developing heart failure.

INTRODUCTION

Overweight and obesity constitute an important public health problem because of the associated increased risk of hypertension, coronary heart disease, type 2 diabetes, stroke, gall bladder disease, certain types of cancer, osteoarthritis, sleep apnea, and other disorders.[1] Body Mass Index (BMI) is currently recognized and widely used for identifying overweight or obesity. Internationally recognized cutoff points of BMI for defining overweight is BMI ≥25.0 kg/m^2 and obesity is BMI ≥30.0 kg/m^2.[2]
The association between obesity and left ventricular dysfunction is well established in adults.[3] The impairment in left ventricular relaxation is one of the effects of obesity on left ventricular function, regardless of the existence of other comorbidities.[4] The presence of diastolic dysfunction of the left ventricle (LV), in the general population, is associated with the development of HF and shorter survival.[5]
Hypertension significantly contributes to cardiovascular (CV) morbidity and mortality by causing substantial structural and functional adaptations, including diastolic dysfunction (DD), left ventricular hypertrophy (LVH), ventricular and vascular stiffness. Chronic hypertension is the most common cause of diastolic dysfunction and failure.[6,7] Present study was aimed for echocardiographic study of the effect of obesity on systolic and diastolic functions of the left ventricle in hypertensive adults.

MATERIAL AND METHODS

Present study was comparative, observational study, conducted in department of physiology, at a tertiary care teaching hospital & medical college in Western

India. Study duration was of 6 months (January 2022 to June 2022). Subjects were selected from patients attending medicine/cardiology outpatient department for treatment/ follow up of hypertension. Permission from cardiology department was taken for the same. Approval for the study was obtained from institutional ethical committee.

Inclusion Criteria

- Cases – Patients of 40-60 years age, of either gender, had hypertension for more than 2 years, had raised body mass index (BMI > 25 Kg/m^2), willing to participate in study.
- Control group: Patients of 40-60 years age, of either gender, had hypertension for more than 2 years, had normal body mass index (BMI 19 – 25 Kg/m^2), willing to participate in present study.

Exclusion Criteria

- Subjects with a history of diabetes mellitus, neuromuscular disorders, chronic respiratory disorders, suspected/diagnosed diagnosed endocrinal disorders, chronic renal disorders
- Smokers and alcoholics
- Subjects with complications of prolonged hypertension such as nephropathy, neuropathy, and peripheral vascular disorders
- Subjects on medication that may affect body weight or have cardiotoxic potential
- Diagnosed with valvular lesions and impaired global/segmental wall motion during the echocardiographic examination.

Study was explained to patients in local language & written consent was taken for participation & study. All patients were examined by the same physician. A detail medical history was obtained. Height and weight were measured using wall mounted stadiometer and Tanita scale respectively. BMI was calculated.

Blood pressure was recorded with electronic apparatus (model 1A2, Omron Corporation, Shimogyo-ku, Kyoto, Japan) in sitting position, on the left arm resting on a table at heart level, after the subject having rested for at least 15 min. Three readings were taken 3 min apart and the mean of the last two readings was recorded as the BP.

Two-dimensional and Doppler echocardiographic examinations were performed with an ultrasonographic system (GE Vivid-T8 Echocardiography system equipped with S3-6 curvilinear probe). Left ventricular ejection fraction (LVEF) was calculated from apical two- and four-chamber views. Left ventricular inflow velocities were measured at the level of the mitral annulus in 4 chamber view.9,10 Early diastolic peak velocity (MF-E wave) and Late diastolic peak velocity (MF-A wave), and ratios of early and late diastolic peak velocities (E/A), deceleration time of E wave (DT), were computer derived. Isovolumetric relaxation time (IVRT), the time interval between aortic valve closure and mitral valve opening was measured.

Diastolic dysfunction was graded according to the diastolic filling pattern

- Grade 1= impaired relaxation pattern with normal filling pressure.
- Grade 2= pseudonormalized pattern.
- Grade 3= reversible restrictive pattern.
- Grade 4= irreversible restrictive pattern.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Frequency, percentage, means and standard deviations (SD) was calculated for the continuous variables, while ratios and proportions were calculated for the categorical variables. Difference of proportions between qualitative variables were tested using chi- square test or Fisher exact test as applicable. P value less than 0.5 was considered as statistically significant.

RESULTS

In present study, 50 cases & 50 controls were studied. Mean age, gender, systolic Blood Pressure & diastolic Blood Pressure were comparable among cases & controls, difference was not significant statistically (p>0.05). Mean weight & BMI was significantly higher among cases as compared to controls & difference was statistically significant (p<0.05).

Table 1: General characteristics

Characteristics	Cases	Controls	*P*-value
Mean Age (years)	47.94 ± 7.34	49.43 ± 9.24	*0.45*
Gender (Male/Female)	31/19	30/20	*0.639*
Weight (kg)	74.84 ± 11.1	58.45 ± 9.35	<0.001
BMI (kg/m2)	28.35± 3.29	22.18 ± 1.29	<0.001
Systolic Blood Pressure (mmHg)	135.44 ± 12.1	136.96 ± 14.2	0.52
Diastolic Blood Pressure (mmHg)	84.42 ± 5.94	83.64 ± 7.3	0.29

Normal diastolic function was seen in 18 % of cases & among 64 % of controls. Among cases diastolic dysfunction was found from grade I (34 %), grade II (24 %), grade III (16 %) & grade IV (4 %). Among controls diastolic dysfunction was found from grade I (20 %), grade II (12 %), grade III (4 %) & none had grade IV. Among cases, there was worsening of diastolic function, Grade III and IV dysfunction was commonly as compared to controls & difference was statistically significant (p<0.05).

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 2: Prevalence of diastolic dysfunction

Diastolic dysfunction Grade	**Cases**	**Controls**	***P*-value**
No dysfunction	9 (18 %)	32 (64 %)	0.003
I	17 (34 %)	10 (20 %)	
II	12 (24 %)	6 (12 %)	
III	8 (16 %)	2 (4 %)	
IV	4 (8 %)	0	

DISCUSSION

Hypertension has a detrimental effect on almost all organs of the body, and its effect on the heart is called as hypertensive heart disease or hypertensive cardiopathy. Hypertension leads to the remodelling of the myocardium in response to chronically elevated blood pressure and wall stress.[8] Left ventricular diastolic dysfunction is a condition reflecting an impairment of the filling properties of the left ventricle, that has been demonstrated to be a predictor of future development of heart failure.[9]

Cardiovascular risk factors and cardiac structural changes associated with obesity/overweight are also major determinants of left ventricular diastolic function.[10] Many causes of the increased LV mass in obese persons had been suggested, those include; increase in the total blood volume as a result of an increase in the size of vascular bed, which will lead to an increase in cardiac output and resultant increased after load, subsequently, those changes may induce cardiac hypertrophy and alterations in LV structure.[11,12]

Assessment of left ventricle function can be performed with several non-invasive (2D- and Doppler-echocardiography, color Doppler M-mode, Doppler tissue imaging, MR-myocardial tagging, radionuclide ventriculography) and invasive techniques (micromanometry, angiography, conductance method). Structural changes in left atrial diameter and left ventricle wall in form of increased mass appears with BMI more than 25 kg/m^2 and continue with further increase in BMI. Left ventricular diastolic function is affected even with mild increase in BMI of 23–24.9 kg/m^2 whereas systolic function is unaltered.[13]

In study by Shree CM et al.,[14] echocardiographic parameters of LV diastolic function were significantly altered in obese hypertensives compared to non-obese hypertensives ($P < 0.05$). About 58% of non-obese hypertensives and 78% of obese-hypertensives had LV diastolic dysfunction. About 6% of non-obese hypertensives and 8% of obese-hypertensives had LV systolic dysfunction. The number of subjects falling into categories of mild-to-moderate diastolic dysfunction was considerably higher in the obese hypertensives compared to the non-obese hypertensives.

In study by Anugya AB et al.,[15] the prevalence of left ventricular systolic dysfunction (LVSD) was 136 (20.9%) in the study population {mild LVSD 78 (12%), moderate LVSD 40 (6.2%), severe LVSD 18 (2.8%)}. In Analysis of Variance (ANOVA), variables such as blood pressure, body surface area, size of left atrium and ventricle, relative wall thickness, stroke volume, left ventricular mass index, diastolic function, ejection fraction, fractional shortening were significantly associated with moderate-severe LVSD.

Chadha DS et al.,[16] noted that ejection fraction, fractional shortening were increased ($p<0.05$) in Overweight Group and obese group. Left ventricular dimensions were increased ($p< 0.001$) but relative wall thickness was unchanged. Systolic dysfunction was not observed in any of the obese patients. The mitral valve pressure half time ($p< 0.01$), left atrial diameter ($p < 0.01$) and the deceleration time were increased ($p< 0.01$) in obese subjects, while other diastolic variables were unchanged. No difference were found between obesity subgroups. BMI correlated significantly with indices of left ventricular systolic and diastolic function.

In study by Prashant SS et al.,[17] BMI was independently associated with higher E, A, and E/E′, an indicator of LV filling pressure (all $p \leq 0.01$). Overweight and obese had lower E′ (both $p<0.01$) and higher E/E′ (both $p<0.01$) than normal weight participants. E/A was lower in obese than normal weight subjects ($p<0.01$). The risk of diastolic dysfunction was significantly higher in overweight and obese compared to normal weight individuals. Hypertensive patients were found to have worse diastolic function as compared to those having normal blood pressure.

Rosa EC et al.,[18] noted that, for a more reliable evaluation of cardiac hypertrophy in the obese, mainly in populations at higher risk, such as the hypertensive population, limits of values of mass/height^2 obtained on the basis of normotensive populations, should be used. This will help to better detect hypertrophy prevalence in the obese and in this way, better stratify the cardiovascular risk in a situation where two potential risk factors, obesity and hypertension, are already present.

CONCLUSION

LV diastolic dysfunction was common in overweight/obesity individuals with hypertension and had risk of developing heart failure. These abnormalities in LV structure and function may have important implications in explaining the myocardial dysfunction associated among individuals with obesity & hypertension, and the associated increased cardiovascular morbidity and mortality.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

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ISSN (O): 2687-5365; ISSN (P): 2753-6556