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Evaluation of structure of obese hearts by two Dimesional echocardiogram

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Abstract

Background: Obesity is rampant in India, particularly in the Southern states. Obesity cardiomyopathy is an evolving disease entity. The effect of simple obesity on cardiac structure is less explored in the Indian population. Echocardiogram is a simple, non invasive technique to assess cardiac morphology. The influence of body mass index and waist circumference on echocardiogram parameters of obese hearts is explored in this study.

Method: Basic demographic information and laboratory investigation of each participant was obtained. Anthropometric measurements (height, weight, waist circumference, body mass index calculation) was done according to standard techniques. Participants were classified according to Asian criteria for obesity. A detailed general and systemic examination was performed. Echocardiogram was performed for all the participants. Statistical analysis was done on the collected data.

Results: Data was collected from 75 study participants who met the inclusion and exclusion criteria. Body mass index (BMI) has a strong correlation with the size of both ventricles. Moreover, both left ventricular mass and left ventricular mass index are directly proportional to the body mass index in individuals with increased BMI. Notably, the sizes of all chambers of the heart are directly proportional to waist circumference. Left ventricle hypertrophy, common in simple obesity, is influenced by BMI.

Conclusion: Asymptomatic structural abnormalities are common in obese hearts even in the absence of comorbidities.

Keywords: Obesity cardiomyopathy, body mass index, waist circumference, echocardiography, simple obesity, Silent cardiac abnormalities

Introduction

Obesity has become a stealthy pandemic affecting people of all ages all over the world, including India. Simple obesity has already been recognized as a cardiovascular risk factor [1]. The severity of obesity is assessed using a multitude of anthropometric parameters. Few previous investigations have found links between body mass index and silent structural abnormalities of heart revealed by echocardiography [2]. There is limited evidence for utilising echocardiography to detect cardiovascular risk in obese people who are otherwise healthy and asymptomatic. This study explores the silent cardiac structural abnormalities in obese individuals by 2D echocardiogram.

Methodology

This was across sectional study conducted in Rajah Muthiah Medical College Hospital, a tertiary care hospital in Cuddalore district, Tamil Nadu during a period of two years spanning from August 2019 to July 2021. Participants belonged to the patient population of RMMCH who attended Medicine Outpatient services.

Inclusion criteria

Patients who were aged 18- 40 Years with no known cardiovascular comorbidities and who consent to participate in the study.

Exclusion criteria

Age < 18 years or > 40 years (to eliminate effects of age-related cardiac changes); known cardiovascular co-morbidity (Diabetes mellitus, hypertension, chronic systemic diseases, anaemia, chronic kidney disease, hypothyroidism, dyslipidaemia on treatment); high blood pressure (Systolic BP>120 mm Hg or Diastolic BP >80 mm Hg); random blood glucose value (>200 mg/dl); abnormal thyroid function assay (as hypothyroidism causes cardiac dysfunction-may confound results); abnormal electrocardiography findings; ischemic or valvular heart diseases; any inter-current illness, Pregnancy.

Sample size: Sample size was calculated for an alpha error of about 0.05 and power of the study was kept as 90%, Sample size was found to be 70 [3].

Procedure

The study was conducted after obtaining clearance from the Institutional Ethics committee and Institutional Scientific Committee. Informed consent from the participants were obtained. The basic demographic information and laboratory investigations of the participants were assessed. A detailed general and systemic examination was performed.

After excluding any abnormalities in the above-mentioned investigations (except for dyslipidemia) and clinical parameters, the anthropometric measurements (height, weight, waist circumference) were done according to standard techniques. [BMI calculated as weight (in kilograms) divided by the square of height (in meters)].

An Echocardiogram was performed for all the participants by the same person using MINDRAY portable echocardiography machine. Detailed structural evaluation of heart was done for each participant as per National Guidelines [4]. An average of two values was taken for every parameter measurement.

- LV linear dimensions {left ventricular end diastolic diameter (LVEDD), left ventricular end systolic diameter (LVESD)} and the left atrium (LA) diameter were measured in parasternal view in M-Mode.
- RA (Right atrium) and RV (Right Ventricle) dimensions were assessed using RV inflow tract long axis view.
- The left ventricular mass (LVM) was calculated by using truncated ellipsoid method. LVM was divided by the body surface area to obtain the left ventricular mass index (LVMI g/m2).
- LV posterior wall in diastole (LVPWD); and interventricular septum in diastole (IVSD) using the parasternal short axis view at the papillary muscle level.
- According to the recommendations for obese patients LVM was also indexed to height, using height squared, as proposed by Rosa and associates, resulting in the LVM / height2 parameter. When the LVM / height2 ratio was elevated, EVH was diagnosed. The LV geometric classification was based on the evaluation of LVM and relative wall thickness (IVSD + LVPWD / LVDD).

Statistical analysis was performed on the collected data using SPSS v25.0. Normally distributed numerical data were represented as mean ± 2SD. Non-normally distributed data as median ± range. Unpaired t test, Mann-Whitney U test and Wilcoxon rank sum test were used. Correlation analysis between BMI, abdominal obesity and echocardiographic characteristics were done using Pearson correlation test $p < 0.05$ was considered significant.

Results

Data are collected from 75 study participants who met the inclusion and exclusion criteria. (Figure1) Out of the 75 participants, 39 belong to the male gender while 36 to female gender. The mean age of the participants is 35.8±6.4 years. The distribution of study participants according to Obesity criteria (BMI, WC) is depicted in the following pie chart. (Figure 2) The patient characteristics (anthropometric parameters and lipid profile) and parameters of structural assessment of heart using echocardiogram are signified in the table. (Table 1)

The echocardiogram parameters and their association with BMI and WC, studied utilizing unpaired t test is represented in table. (Table 2)

The right ventricle dimension and LVEDD are found to be significantly higher in patients with higher BMI. Other chamber measurements are identical in all the patients irrespective of BMI. Strikingly, the LV mass as well as LV mass index are significantly higher in the overweight/obese participants in comparison with those who have normal BMI. The structural evaluation also reveals that significantly higher dimensions of all the chambers of the heart in participants with increased waist circumference (WC) than those with normal waist circumference. In contrast to BMI, the waist circumference is not statistically associated with LV mass or LV mass index.

Among the various LVH (LV hypertrophy) patterns, concentric LVH was observed in 6.7%, eccentric LVH in 36% and remodelling in 28% of the participants while the remaining had no LV hypertrophy. Types of LVH and their association with BMI analyzed by the Mann-Whitney U test and/or Wilcoxon rank sum test is found to be statistically significant (p values for concentric LVH, eccentric LVH and Remodelling are 0.04, <0.001 and <0.001, respectively). Types of LVH and their association with WC is not found to be statistically significant (p values for concentric LVH, eccentric LVH and Remodelling are 0.43, 0.59 and 0.16, respectively). There is no association between LV hypertrophy and waist circumference.

The correlation analyses between various echocardiogram parameters and BMI, WC are done using Pearson correlation technique, represented in the following table. (Table 3)

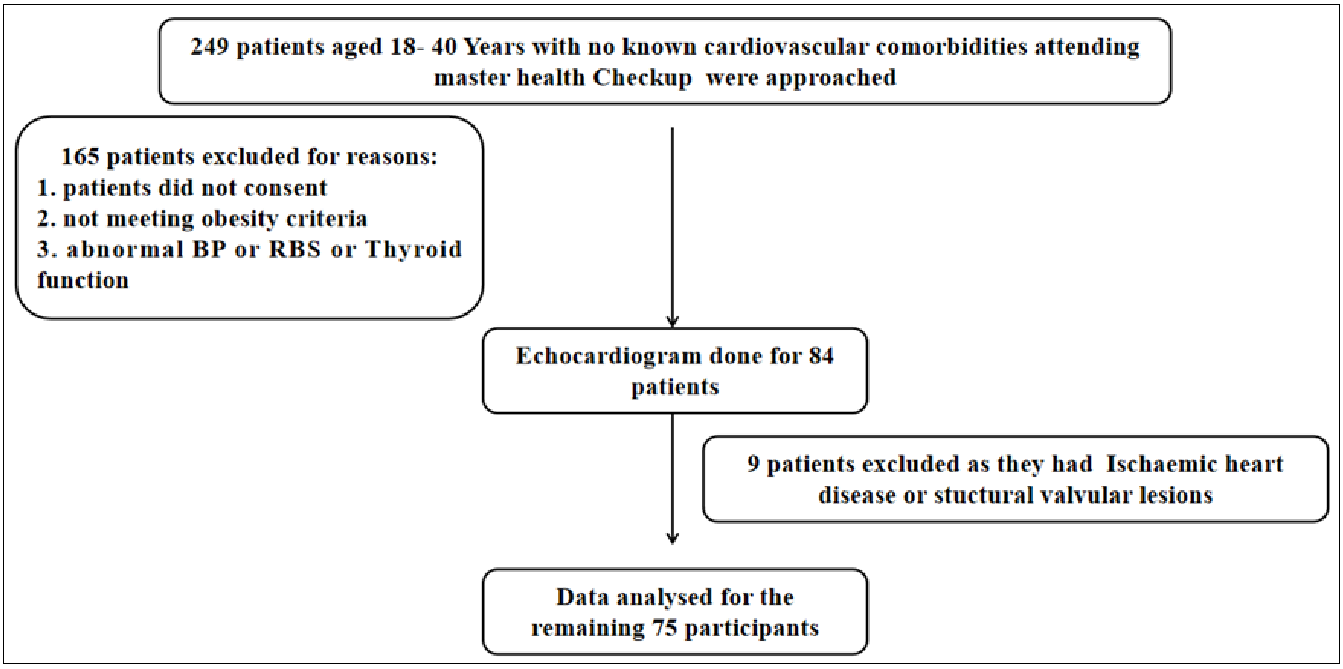

Fig 1: Strobe diagram exhibits data collection details

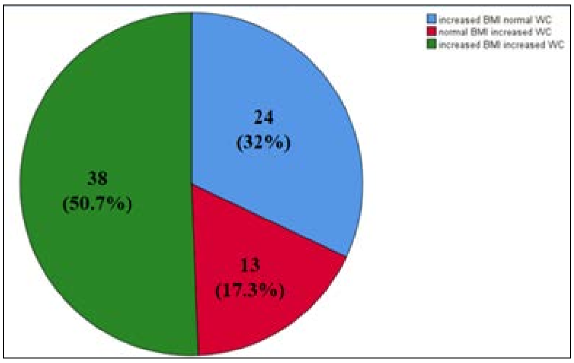

Fig 2: Distribution of study participants according to Obesity criteria is revealed in this pie chart (n=75)

Table 1: Patient characteristics and Echocardiogram parameters for structure assessment

Patient Characteristics (n=75)	Mean ± 2S.D.
BMI (kg/m2)	24.5±1.6
Waist circumference (cm)	89.08±8.3
ECHO Parameters (n=75)	Mean±2S.D.
Structure	
Left atrium (mm)	40.3±5.4
Left ventricle (mm)	53.4±7.2
Right atrium (mm)	33.2±8.6
Right ventricle (mm)	26.6±2
LVEDD (mm)	53.4±19.3
LV mass (g)	163.3±43.8
LVMI (g/m2)	91.9±20.3

Table 2: Association of BMI and WC to echocardiogram parameters

Echo parameters	BMI <23kg/m2 (n=13)	BMI >=23kg/m2 (n=62)	p-value
Left atrium (mm)	40.6±3.8	40.2±5.7	0.81
Left ventricle (mm)	50.8±6.1	53.9±7.3	0.15
Right atrium (mm)	31.5±3.3	33.5±9.3	0.46
Right ventricle (mm)	25±1.2	26.9±1.9	0.001
LVEDD (mm)	39.8±8.6	56.3±19.8	0.004
LV mass (g)	104.7±17.4	175.6±37.1	<0.001
LVMI (g/m2)	61.5±8.2	98.2±15.8	<0.001
Echo Parameters	Abdominal obesity present	Abdominal obesity absent	p-value
Left atrium (mm)	34.5±5	43±2.8	<0.001
Left ventricle(mm)	56.5±6	46.7±4.5	<0.001
Right atrium (mm)	24.1±7.6	37.4±5	<0.001
Right ventricle (mm)	25±1.7	27.3±1.7	<0.001
LVEDD (mm)	54.9±17.4	52.7±20.3	0.66
LV mass (g)	169.8±37.8	160.3±46.4	0.39
LVMI (g/m2)	94.9±14.2``	90.4±22.6	0.38

Table 3: Correlation analysis by Pearson technique between BMI, WC and echocardiogram parameters for structural assessment

Parameters	Significance	Correlation coefficient (r value)	Implication
Correlation with BMI			
LA (mm)	0.74	-0.04	No correlation
LV (mm)	0.02	0.27	Weak correlation
RA (mm)	0.32	0.12	No correlation
RV (mm)	0.007	0.31	Moderate correlation
LVEDD (mm)	<0.001	0.77	Strong correlation
LV Mass (g)	<0.001	0.86	Strong correlation
LVMI (g/m2)	<0.001	0.80	Strong correlation
Correlation with WC			
LA (mm)	0.01	0.28	Small correlation
LV (mm)	< 0.001	0.68	Strong correlation
RA (mm)	0.005	0.32	Moderate correlation
RV (mm)	0.002	0.35	Moderate correlation
LVEDD (mm)	0.88	-0.02	No correlation
LV Mass (g)	0.56	0.07	No correlation
LVMI (g/m2)	0.80	-0.03	No correlation

Discussion

Our study details the gravity of silent cardiac structural changes in young asymptomatic adults with uncomplicated obesity.

Type of Obesity

Among the 75 participants, the proportion of isolated generalized obesity, isolated abdominal obesity and combined obesity (both generalized and abdominal obesity) are 32%, 17.3% and 50.7% respectively.

Another study on obesity in eastern India discovered that 44% of obese adults had generalised obesity, 14% had abdominal obesity, and 42% had both generalised and abdominal obesity [6].

Teenagers with abdominal obesity had a higher risk of developing metabolic syndrome, according to findings from an Iranian study on childhood obesity. Additionally, teenagers with both generalised and abdominal obesity had a significantly greater rate of metabolic syndrome (25%) than those with only one kind of obesity. We extrapolate that the majority of our study participants are at high risk of developing metabolic syndrome in the future because abdominal obesity is considered an atherogenic variant of adiposity [6].

BMI and echocardiographic assessment of heart's structure

Individuals with a higher BMI had a significantly larger right ventricular size and left ventricular diastolic dimension in our study. Other chamber dimensions are unaffected by isolated generalized obesity. In this study, not only the LV mass but also LVMI were significantly larger in overweight/obese patients than in those with a normal BMI. Individuals with a higher BMI had a higher rate of all types of LVH than adults of normal weight, according to our findings.

Many Indian researchers have probed into the association of BMI and structural alterations in heart in various regions of the country and have achieved mixed results [7, 8, 9]. To summarize, generalized obesity was linked to silent cardiac structural abnormalities. Several studies that looked into obese hearts discovered that chamber enlargement and ventricular hypertrophy were common findings [10].

WC and echocardiographic assessment of heart's structure

Surprisingly, structural cardiac assessment by echocardiogram reveals that the diameters of all the cardiac chambers are greater in participants with abdominal obesity than in those with a normal waist size. Waist circumference, unlike BMI, has no statistical link to the LV mass or LV mass index. In our participants, exclusive abdominal obesity has no effect on LV hypertrophy.

The size of left atrium was found to be significantly influenced by abdominal circumference in a research exclusively done for obese women.[11] However, studies analyzing abdominal obesity's effects on cardiac morphology are limited.

The strength of our study is the evaluation of isolated obesity's influence on cardiac structure and comparison of the influence of different obesity patterns. The limitations of our study are lack of gender wise analysis for echocardiogram parameters, and inability to understand the influence of comorbidities, reversibility of obesity cardiomyopathy.

Conclusion

The BMI has a strong correlation with the size of both ventricles. Moreover, both left ventricular mass and left ventricular mass index are directly proportional to the body mass index in individuals with increased BMI. Notably, the sizes of all chambers of the heart are directly proportional to waist circumference. LV hypertrophy is common in obesity.

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Conflicts of Interest: Nil

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