Echocardiographic Assessment of Left Ventricular Function in Overweight and Obese Subjects

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Summary:

Background: Obesity is a public health concern worldwide associated with significant health risks and comorbid conditions. Obesity might be a strong factor that can induce left ventricular systolic dysfunction and eventually cause heart failure independent to coronary artery disease or other morbidities. In uncomplicated obese subjects, diastolic dysfunction is caused by hemodynamic and metabolic factors.

Objectives: To assess the left ventricular (systolic and diastolic) function in a sample of overweight and obese subjects using different Echocardiographic tools and exploring the percentage and type of diastolic dysfunction in those people.

Subjects and methods: one hundred seven (107) normal adult males subjects with a mean age of (39.3± 7.5) years were involved in this study. The study was performed during the period from September 2012 until July 2013, at the echo unit of Ibn Al-Bitar hospital for cardiac surgery.

Results: Regarding E/A ratio there were statistically significant decrease in the E/A ratio of Group 1(normal body weight) when compared with that of Group3(obese). Deceleration time(DT), Isovolumetric relaxation time(IVRT) and E/Vp ratio showed a statistically significant increase when comparing Group1 with Group3. Regarding velocity of flow propagation(VP) there were statistically significant decrease when comparing Group1 with Group2 and Group 1 with Group3. Higher percent of subjects in group1 developed normal diastolic function(44%), while higher percent of subjects who found to have impaired relaxation were those in group3(68%), also higher percent of subjects with pseudonormal type were found in group3(57%) when compared to group1& 2.

Conclusion: The relationship between BMI and diastolic function parameters is continuous and independent of cardiovascular risk factors that cluster with obesity, such as hypertension, diabetes, and LV hypertrophy. The overweight status is already associated with an impairment of LV diastolic function, close to that observed in obese persons.

Keywords: obesity, overweight, diastolic dysfunction.

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Introduction:

Obesity is a public health concern worldwide associated with significant health risks and comorbid conditions. Obesity can be defined as an excess of body fat. A surrogate marker for body fat content is the body mass index (BMI), which is calculated as: BMI = Weight in kg/Height squared in m2

In clinical terms, a BMI between 25 and 29.9 kg/m is called overweight, and a BMI greater than 30 kg/m is called obese. BMI is not a direct estimate of adiposity and does not take into account the fact that some individuals have a high BMI due to a large muscle mass (1).

Complications of obesity: Include cardiovascular disease, hypertension, dyslipidemia, endothelial dysfunction, type-2 diabetes mellitus and impaired glucose tolerance (2).

A variety of techniques in many studies have been used to evaluate LV systolic function in obesity. Findings have ranged from depressed to normal to supranormal ejection fraction (EF). Obesity might be a strong factor that can induce LV systolic dysfunction and eventually cause heart failure independent to coronary artery disease or other morbidities (3).

In uncomplicated obese subjects, diastolic dysfunction is caused by hemodynamic and metabolic factors. Hemodynamic changes cause diastolic dysfunction in obese subjects through LV hypertrophy (4). Other potential mediators include hormones and cytokines released in association with obesity. Changes of adipokine concentration in serum, such as leptin and adiponectin, are observed in obese subjects, which may also be partly responsible for the LV diastolic dysfunction (5).

The aim of this study is to: Assess the left ventricular (systolic and diastolic) function in a sample of overweight and obese subjects using different Echocardiographic tools, explore the percentage and type of diastolic dysfunction in those people, according to the grades of diastolic dysfunction and evaluate the left side filling pressure to early specify and diagnose people at risk for development of normal ejection fraction heart failure.

Subjects and Methods:

This study involved one hundred seven (107) normal adult male subjects with a mean age of (39.3± 7.5) years, they

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were divided into three groups according to their body mass index(BMI):
Group 1with normal body mass index (18.5-24.9kg/m²) [34 subjects].
Group2 overweight (BMI 25-29.9kg/m²) [36 subjects].
Group3 obese (BMI ≥30 kg/m²) [37 subjects].
This study was performed during the period from September2012 until July 2013, at the echo unit of Ibn Al-Bitar hospital for cardiac surgery.
The plan of the study consisted of the following steps
Case history, Clinical & physical examination, Body mass index (BMI), waist circumference (WC) and body surface area (BSA) calculation, Electrocardiography (ECG), Echocardiographic examination (The echocardiography was performed for each subject using Phillips (IE33 model) system (USA) echocardiographic device, with a transducer operating at S3.5 MHz). The measurements were taken using M-mode guided by two-dimensional, Doppler (Continuous wave and Pulsed wave). Blood sample for lipid profile estimation, Blood sugar, Blood urea and Serum creatinine (to determine hypercholesterolemia, renal failure and D.M) .
Exclusion criteria include:
Smoking, History of (IHD, Hypertension, DM, Hypercholesterolemia, Congenital or rheumatic heart disease and cardiac arrhythmia, renal failure) and Patients with poor window study.
Statistical Analysis:
All calculations and analyses were performed using Statistical Package for the Social Sciences, (SPSS version 17 for windows, SPSS Inc., Chicago, Illinois) computerized Program. Clinical and echocardiographic data were presented as mean ± standard deviation (SD) for continuous variables or as numbers with percentages for categorical variables. The chi-square test was used to assess differences among proportions of categorical data. The level of statistical significance was defined as P value <0.05, which was obtained by comparing the calculated t-value to the tabulated t-value at 95% confidence interval. The one-way analysis of variance with the completely randomized design (ANOVA) test was used to assess differences among more than two means of continuous data.

Results:
The demographic characteristics of the 107 subjects involved in this study are shown in table (1). It is clear from this table that there was no significant differences in age and body height (B. height) between the groups (0.072, 0.918) respectively. But there were significant differences in body weight(B.wt), waist circumference(WC), body mass index(BMI) and body surface area(BSA) between the groups (0.0001, 0.0001, 0.0001, 0.0001) respectively.

Table1: The Demographic characteristics of subject groups.

Parameters	Group 1 (normal weight) n=34	Group2 (overweight) n=36	Group 3 (obese) n=37	P value
Age(year)	37.7 ± 7.7	38.5 ± 7	41.5 ± 7.5	0.072
B.wt(kg)	66.8 ± 9.8	83.2 ± 9.7	104.8 ± 17.7	0.0001*
B.height(cm)	172.5 ± 10.1	173.4 ± 9.1	173.2 ± 9.5	0.918
WC(cm)	82.1 ± 6.9	97.6 ± 11	116.5 ± 15.3	0.0001*
BMI(kg/M')	22.4 ± 2.3	27.6 ± 1.3	34.9 ± 4.7	0.0001*
BSA(m²)	1.8 ± 0.2	1.10 ± 0.2	2.2 ± 0.2	0.0001*

- Values were expressed as mean±SD.
- *SignificantP-value less than 0.05.
- B.wt: Body Weight, B.height: Body height,

WC: Waist Circumference, BMI: Body mass index,
BSA: Body surface area.

Regarding the Systolic function parameters between subject groups, as shown in table 2, there were no statistically significant differences in EF(ejection fraction; (by M-mode and by Simpson method), FS(fractional shortening) between the three groups studied.

Table 2: Systolic function parameters of subject groups.

Systolic Function parameters	Group1 (n=34)	Group2 (n=36)	Group3 (n=37)	G1vsG2 P-value	G1vsG3 P-value	G2vsG3 P-value
EF(%)	64.1 ± 6.5	63.2 ± 7.4	64.4 ± 8.6	0.628	0.873	0.512
EF2(%)	65.2 ± 6.7	63.1 ± 7.4	64.3 ± 8.5	0.272	0.633	0.522
FS(%)	41.1 ± 7.7	39.7 ± 6.4	40.8 ± 7.5	0.429	0.904	0.493

- Values were expressed as mean±SD.
- EF=Ejection fraction by M-mode, EF2=Ejection fraction by Simpson

FS=Fractional shortening.

The Pulsed-Doppler results of subject groups were expressed in Table 3.

Concerning the Peak A –wave there were a statistically significant differences between Group 1 with that of Group3 (0.001) and between Group 2 with Group3 (0.001).

Regarding E/A ratio there were statistically significant decrease in E/A ratio of Group 1 when compared with that of Group3(P= 0.0001) and of Group 2 with that of Group3(P= 0.011), but no significant difference were noticed between Group1 and Group2.

Deceleration time(DT) and Isovolumetric relaxation time(IVRT) showed a statistically significant elevation in DT when comparing Group1 with Group3(190.3 ± 18.2 vs 219.6 ± 34.7 with P-value=0.0001) and Group2 with Group3(191.6 ± 35.7 vs 219.6 ± 34.7 with P-value=0.0001).

Also there were a significant elevation in IVRT when comparing Group1 with Group2 (77.5 ± 6.5 vs 85.9 ± 9.2 with P-value=0.0001), Group1 with Group3 (77.5 ± 6.5 vs 87.5 ± 12.1 with P-value=0.0001) but not significant between Group2 with Group3 (85.9 ± 9.2 vs 87.5 ± 12.1 with P-value=0.479).

Regarding velocity of flow propagation(VP) there were statistically significant decrease when comparing Group1 with Group2 (61.5 ± 6.3 vs 54.1 ± 7.6 with p- value=0.0001), Group 1 with Group3 (61.5 ± 6.3 vs 51.5 ± 8.9 with P-value 0.0001) but not significant between Group2 with Group3(54.1 ± 7.6 vs 51.5 ± 8.9 with P-value=0.157). E/Vp ratio showed statistically significant increase when we compare Group 1 with Group 3(1.3 ± 0.2 vs 1.6 ± 0.3 with P-value 0.0001) and Group 2 with Group 3(1.4 ± 0.3vs1.6 ± 0.3 with P-value 0.001) but not significant between Group 1 with Group 2(P-value 0.469).

Table 3: Pulsed-Doppler echocardiographic parameters of subject groups.

Pulsed-Doppler Parameters	Group1 (n=34)	Group2 (n=36)	Group3 (n=37)	P-value
Peak E-wave (cm/s)	82.1 ± 16.4	74.1 ± 17.3	80.1 ± 15.1	0.105
Peak A-wave(cm/s)	63.4 ± 13.8	63.1 ±17.9	77.6 ± 19.5	0.0001*
E/A ratio	1.3 ± 0.16	1.22 ±0.27	1.08 ± 0.27	0.0001*
DT(msec)	190.3±18.2	191.6±35.6	219.6±34.7	0.0001*
IVRT(msec)	77.5 ± 6.5	85.9 ± 9.2	87.5 ± 12.1	0.0001*
VP(cm/s)	61.5 ± 6.3	54.1 ± 7.6	51.5 ± 8.9	0.0001*
E/Vp	1.3 ± 0.2	1.4 ± 0.3	1.6 ± 0.3	0.0001*

Values were expressed as mean±SD.

- *SignificantP-value less than 0.05.
- Group1=normal weight, Group2= overweight, Group3= obese.
- DT=Deceleration time , IVRT=Isovolumetric relaxation time,

VP=Velocity of flow propagation.

The diastolic function of subject groups were shown in figure 1, it is clear that higher percent of subjects in group1 developed normal diastolic function (44%), while higher percent of subjects who found to have impaired relaxation were those in group3(68%), also higher percent of subjects with pseudonormal type were found in group3(57%)when compared to group1& 2(P =000.1) . Restrictive pattern was not present among the subjects studied.

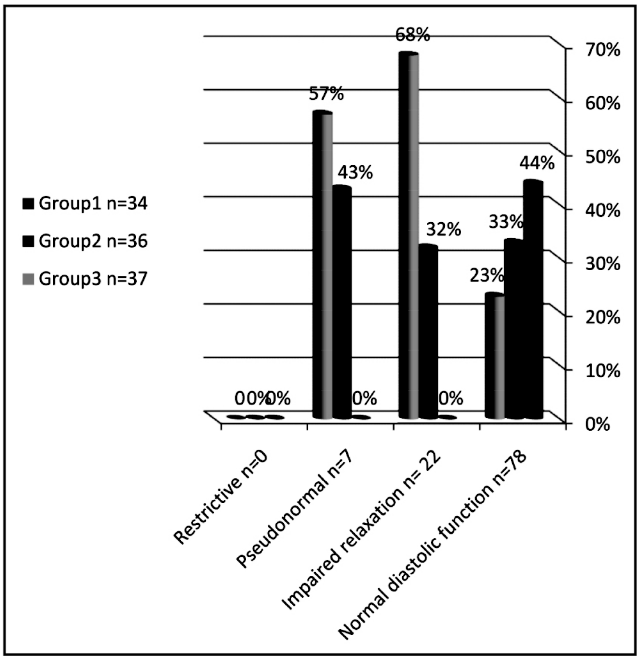

Figure1: The Diastolic function of subject groups.

Discussion:

The prevalence of obesity is steadily increasing worldwide and constitutes a major health issue because of its association with morbidity, mortality, and cardiovascular diseases (6). An increase in body size, besides being associated with cardiovascular risk factors such as hypertension, diabetes mellitus, and hyperlipidemia, directly affects cardiac structure and function (7). Echocardiography indeed can reliably detect and grade the severity of diastolic dysfunction, estimate filling pressure, and provide prognostic insights for Diastolic heart failure as well as for Systolic heart failure(8). The range of the age in our study group was between (26-51) years as shown in (table 1) this make the physiological reversal of the E/A ratio (as in the aging people) is not present. We divided our groups according to their BMI in which: Group 1with normal body mass index (18.5-24.9kg/m²), Group2 overweight (BMI 25-29.9kg/m²), Group3 obese (BMI ≥30 kg/m²), this grouping of the study subjects was similar to what was done by (9). Regarding abdominal obesity, a waist circumference of 102cm in men indicates that the risk of metabolic and cardiovascular complications of obesity is high as (10).

From the results of the present study about the left ventricular systolic function namely ejection fraction (EF) and fractional shortening (FS) as shown in (table 2) all the values were within normal values and that's one of the important inclusion criteria in selecting patient in this study. Although all the values were within normal, It is clear that no significant changes of the ejection fraction and fractional shortening happened with the increase in the body mass index in between the 3groups, which was in agreement with the results of (11)(12), this means that the systolic LV function remain normal with no significant difference between the 3 groups. It's obvious from the examination of pulsed wave Doppler parameters (table3), that the obese and overweight subjects revealed the lower value of E-wave velocity, E/A ratio and lower velocity of flow propagation(VP) with the enhanced values of A-wave, with prolongation of the deceleration time and IVRT in comparison with control group ($p<0.05$). This can be explained by the increased diastolic dysfunction and possibility of increased filling pressure of the left side of the heart.

The progressive increase in the A-wave and decrease in E-wave might indicate a low pressure gradient between left atrium and left ventricle. This serves as a compensatory mechanism in case of reduction in blood flow that occurs as there is a decrease in the peak E-wave velocity during the passive stage. As a result, the left atrium will propel a large volume of blood as a compensatory action to maintain adequate stroke volume and this lead to a higher A-wave and hence lowering E/A ratio, these results go in parallel with the studies of (13)(14)(15). As it was illustrated from(figure 1), the higher percent of subjects who found to have impaired relaxation were those in obese group (15 patients ; 68%), also higher percent of subjects with pseudonormal type were found in obese group (4 patients; 57%) while in overweight group (7 patients; 32%) suffer from impaired relaxation and (3 patients; 43%) have pseudo normal type. These results were in parallel with the results of (12) who mentioned that LV diastolic function decreases in all graded of BMI more than 23kg/m². These results propose that a possible pathophysiological explanation for the association of central adiposity and increased BMI with worsened cardiovascular outcomes which are due to the effect of central adiposity on LV diastolic function(10)(16). In fact, no significant differences were found in most parameters of diastolic function between obese and overweight subjects.

Conclusions:

Echocardiography is a valuable tool in evaluating Left ventricular function in obese subjects. The relationship between BMI and diastolic function parameters is continuous and independent of cardiovascular risk factors that cluster with obesity, such as hypertension, diabetes, and LV hypertrophy. The overweight status is already associated with an impairment of LV diastolic function, close to that observed in obese persons. Overweight and obese subjects had also higher risk of apseudonormalized diastolic pattern.

Author's Contributions:

Reem J. Jaber: An MSc. Student who collects the subjects and examines them and performs the Echocardiographic examinations and writes the thesis.

Affan E. Hassan: The supervisor who arranges the protocol of the study and help in doing the statistical analysis and in writing the thesis.

Layth R. Taqa: Subspecialist cardiology at Ibn-Albitar Hospital who help the student in examining the subjects and collecting the data of the study and in performing the echocardiographic examination.

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