Effect of Body Mass Index on Left Ventricular Diastolic Function

تأثير الزيادة في معامل كتلة الجسم على الوظيفة الانبساطية للبطين الايسر

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الخلاصة
خلفية البحث: إن الأشخاص المصابون بالسمنة وذوي الوزن الزائد معرضون الى عجز القلب،وهنالك تأثير مباشر ومستقل للسمنة على القلب ولغاية الان لم يكتسب الموضوع الدرجة القطعية.
الهدف :تقييم زيادة مؤشر كتلة الجسم على الوظيفة الانبساطية للبطين الأيسر.
المنهجية: دراسة سريريه مقطعية تم فيها قياس الوظيفة الانبساطية للبطين الأيسر وأجريت على (١٧٥) من الأشخاص الأصحاء و من كلا الجنسين (٦٨ إناث و ١٠٧ ذكور)، تتراوح أعمارهم ما بين ٢٦ و ٤٩ سنة (٣٧.٥ ± ٩.٥) علما أن الاشخاص لا يشكون من أي حالة مرضية أخرى. تم تقسيم عينة الدراسة إلى ٣ مجاميع وفقا لمؤشر كتلة الجسم (كجم / متر مربع): {الوزن الطبيعي (١٨.٥-٢٤.٩)}، {يعانون من زيادة الوزن (٢٥-٢٩.٩)} والبدانه {(≤ ٣٠)} وقد لوحظ الإنخفاض في مؤشرات فحص الصدى القلبي للوظيفة الإنبساطية اليسرى، وقد سجل الخلل عندما يكون اختلاف في إثنين على الأقل من القيم المسجلة بقيمة أعلى أو تساوي ضعف قيمة الانحراف المعياري عن مجموعة الوزن الطبيعي.
النتائج: كان الإختلال في الوظيفة الانبساطية أعلى بكثير في المجموعة التي تعاني من زيادة الوزن والسمنة مقارنة بالمجموعة ذات مؤشر كتلة الجسم الطبيعية. وكان زمن التباطؤ(IDT) ذو قيمة معنوية كبيرة(p< ٠.٠١)، كذلك قطر الأذين الأيسر (p< ٠.٠١) أيضا كان أكثر في الأشخاص الذين يعانون من البدانة، بينما كانت المتغيرات الأخرى في الوظيفة الانبساطية للقلب غير معنوية. لم يتم العثور على فرق معنوي بين المجموعات الفرعية للسمنة. مؤشر كتلة الجسم يرتبط بشكل معنوي كبير مع مؤشرات الوظيفة الانبساطية للبطين الايسر.
الاستنتاج: لوحظ ضعف,دون السريري في الوظيفة الإنبساطية للبطين الأيسر في كل تقسيمات السمنة التي ترتبط بمؤشر كتلة الجسم، وكانت أكثر أهمية في الذكور منها في الإناث.
التوصيات: الأشخاص الذين يعانون من البدانة أو الزيادة في الوزن هم بحاجة الى المتابعة وإعادة التقييم المستمرة وكذلك هم بحاجة الى التشجيع للانخراط في برامج تقليل الوزن المختلفة.
مفاتيح الكلمات: معدل كتلة الجسم،عجز البطين الايسر،الانبساطي، صدى القلب.

ABSTRACT
Introduction: Overweight and obese persons are at increased risk for heart failure. A direct effect of isolated obesity on cardiac function is not well established.
OBJECTIVE: To assess the independent effect of increased body mass index on the left ventricular diastolic function.
Methodology: cross sectional study to measure of the left ventricular diastolic function was carried out on (175) apparently healthy persons from both sex (68 female and 107 male) aged between 26–49 years (37.5±9.5). Personnel without any other pathological condition were studied. The study sample was divided into 3 groups according to their body mass index (kg/m²): [normal (18.5-24.9), overweight (25-29.9) & obese (≥ 30)]. Echocardiographic indices of left diastolic function were obtained, and dysfunction was assumed when at least two values differed by ≥ 2 SD from the normal weight group.
Results: Diastolic dysfunction was significantly higher in overweight and obese groups compared to the normal body mass index group. The deceleration time was with significant P-value (<0.01) and left atrial diameter (p< 0.01) was more in obese persons, while other diastolic variables were unchanged. No differences were found between obesity subgroups. Body mass index correlated significantly with indices of left ventricular diastolic function.
Conclusions: Subclinical left ventricular diastolic dysfunction was noted in all grades of obesity which correlates with body mass index, and more significant in males than females.
Recommendations: people who are suffering from obesity are recommended for follow up and assessment, also they are in need for encouragement to active participation in weight reduction programs.
Keywords: Body mass index; Diastolic function; Echocardiography**.**

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INTRODUCTION

Obesity is one of the most pervasive, chronic disease in need of new strategies for medical treatment and prevention[1]. Obesity is defined as excess adipose tissue or an exaggeration of normal adiposity and is a central player in the pathophysiology of diabetes mellitus, insulin resistance, dyslipidemia, hypertension and atherosclerosis.[2]

In obesity, Many adipokines and other chemical mediator like tumor necrosis factor –alpha, interleukin-6, plasminogen activator inhibitor-1, resistin, lipoprotein lipase, cholesteryleaster transport protein, esterogens, leptin, angiotensinogen, and insulin like growth factor-1 are present in increased concentrations in obese patients. These have various adverse effects on the cardiovascular system by creating a pro inflammatory and prothrombotic state as well as causing endothelial damage vascular hypertrophy[3]. The excess on body fat determines an increase in both preload and after load due to a hyperdynamic circulation, chronic volume overload, metabolic demand, peripheral resistance and greater conduit artery stiffness[4].Abnormal diastolic function is the most important component of impaired function. Diastolic heart failure occurs when the ventricular chamber is unable to accept an adequate volume of blood during diastole, at normal diastolic pressure and at volume sufficient to maintain an appropriate stroke volume. These abnormalities are caused by a decrease in ventricular relaxation and/ or an increase in ventricular stiffness[5,6]. The initial classification of diastolic filling is based on the measurement of E-wave and A-wave velocities and E/A ratio. Mitral valve inflow pattern, impaired LV relaxation pattern, restrictive left ventricle filling pattern. In healthy, young, disease-free individuals the E-wave exceeds the A-wave, and therefore the E/A ratio is more than 1 as shown below .With advancing age, there is natural stiffening of the ventricle which result in delayed relaxation and therefore a progression decrease in E-wave velocity and an increase in A-wave velocity with age so that the E / Aratio in a disease free individuals is often less than 1 [7,8].{If echoparmeters are normal, patient age <45 Years and E>A: Normal diastolic function}

In impaired ventricle relaxation pattern, the initial alteration of diastolic filling is impaired or slowed myocardial relaxation. When myocardial relaxation is markedly delayed, patients have a mitral filling pattern with prolonged is volumetric relaxation time (> 200) and deceleration time (> 220), decreased E –wave velocity and increase A-wave, since more of the ventricular filling happens to occur at the end of it, with atrial contraction. This produces an A/E ratio < 1 and deceleration time > 240 ms have high specificity for abnormal LV relaxation[8,9].{If A is higher than E (E/A ration is<1):Impaired relaxation} with Filling pressure is normal or mildly elevated

In restrictive left ventricular filling pattern represents a combination of a stiff, non-complaint ventricle and elevated LV end- diastolic pressure. Increase left atrial pressure produce an earlier opening of the mitral valve, a shorting of IVRT and increased initial transmitral gradient(high E-wave velocity). Early diastolic filling in a non-distensible ventricle cause a rapid equalization of LV and LA pressures which produce a shortening of the deceleration time. Therefore, the restrictive physiology is characterized by increased E-wave velocity, decreased A-wave velocity, E/A ratio> 2, shortened deceleration time (< 160 ms) and isovolumetric relaxation time (< 70 ms). A restrictive physiology pattern identifies advanced, usually symptomatic disease, with a poor prognosis.{If E is twice A (E/A ratio is >2) then: Restrictive pattern with Filling pressure elevated.

In pseudo normal left ventricular pattern, there is a transitional phase between abnormal relaxation and restrictive physiology. During this transition, the incoming mitral flow pattern, E/A ratio of 1- 1.5 and a normal deceleration time (160-200).This is result of a moderate increase of filling pressure decrease compliance. This pattern represents a moderate stage of diastolic dysfunction. Changes of mitral inflow during valsalva maneuver have a moderate diagnostic value for the differentiation of normal and pseudo normal pattern.[8,10,11]{If echoparmeters are abnormal (LVH, reduced LVEF, etc.) or patient age>65 Year and E is higher than A (E/A ratio>1)Pseudo normal pattern}

Tissue Doppler study echocardiography has consistently been the most accurate noninvasive method of assessing the left ventricular function, but when volume overload is present, as seen in obesity, normal values may result, as the increase in left atrial pressure caused by intravascular volume can mask the alterations observed in early phases of abnormal relaxation time[12]. The alterations in diastolic function were common, not only in severely obese personnel, but also in overweight subjects. These alterations correlated strongly with BMI. In obesity, cardiac adaptation to chronic volume overload is associated with eccentric hypertrophy and abnormalities of diastolic function[13].

OBJECTIVE

The aim of this study was to investigate the direct effect of different grades of isolated obesity on echocardiographic indices of the left ventricular diastolic function in both men and women.

METHODOLOGY

The study was performed between June of 2015 till January of 2016 at the Echocardiography unit in Rizgary teaching hospital, Erbil city, which included 175 asymptomatic persons of 68 females and 107 males, their age ranged from 26 to 49 years(mean 37.5±9.5).The study group included medical staff, and patient relatives. Personal and health information was taken after obtaining an informed consent from all participants. History and clinical examination:- the following criteria for subject exclusion were considered: The presence of any previous history of clinical evidence of diabetes mellitus, coronary heart disease, hypertension, heart failure or cardiac valve disease, dyslipidemia, renal impairment, respiratory disease, malignancy, and taking any drugs that could affect the heart. All participants provided information on age, family history, personal habit (alcohol intake, tobacco, consumption), so after taking medical history, a detailed physical examination was conducted for all participants which included recording of height and weight without wearing shoes. Body mass index was calculated by dividing the body weight (in kilograms) by the square of height (in meters).[14]A 12 –lead electrocardiogram was obtained(Brand: GE medical system, model: MAC 1600; India), and abnormal ECG was excluded from the study. Blood pressure was measured by mercury sphygmomanometer at the time of visit (mean of 2 readings). Hematological and biochemical variables were determined from fasting blood samples, and this included glucose, HbA1C, total cholesterol, triglyceride, high density lipoprotein cholesterol, low density lipoprotein cholesterol, urea, and full blood count. The participants in the study were classified into three groups based on the BMI: a normal weight group had a BMI between 18.5-24.9 kg/m^2, an overweight group had a BMI between 25-29.9 kg/m^2, and an obese group had a BMI $\geq$ 30 kg/m^2 [14].

The number of participants in each group was 58, 77, 40 respectively. Echocardiogram was obtained on all individuals to assess ventricular diastolic function. Echo-tissue Doppler (Brand GE; vivid 3 N -2006) measurements were obtained in the apical four chamber view. The Doppler beam was aligned perpendicular to the plane of the mitral annulus.

The left atrial diameter was measured using M mode in the parasternal long axis view. M-mode recordings were obtained with the subject in the supine and left lateral decubitus position. Left ventricular diastolic function was assessed by calculating the following variables :Maximum velocity of passive mitral filling (E), Maximum velocity of active mitral filling (A), ratio of passive to active velocity (E/A), Deceleration time(DT).Normal E/Aratio is 1.53±0.40(0.73–2.33) for 20 t0 40 year age, while 40 to 60 year age is 1.28±0.25(0.78–1.78), DT(m/sec) 184 ± 24 [15]. Subclinical diastolic dysfunction was assumed when two or more indices of altered diastolic function were present.

STATISTICAL ANALYSIS:

Statistical analysis done by MedCalc software. Descriptive statistics were done on each of the variables to obtain the frequency distributions. Quantitative variables were described as mean. Comparisons between the obese group and the normal weight group were analyzed by *t*test. Correlation coefficient (r) was obtained to demonstrate the correlations between variables and left ventricular diastolic function. Probability value of P≤0.05 were considered significant.

Results: only weight and BMI were significantly different within the obese weight groups (P< 0.001), with respect to the normal weight group.

Table (1): Baseline characteristics of study population

	Group I Normal(N=58)	Group II Overweight(N=77)	Group III Obese(N=40)	P value (Overall)
Age(years)	37.5 ± 9	9.5±37.3	8.5±37.2	0.086
Weight(kg)	7.4±69.8	10.2±78.2	12.4±93.3	< 0.001
Height(m)	6.9 ±1.69	5.8±1.66	6.3±1.67	0.076
BMI(kg/m²)	1.2±22.1	1.2±27.2	2.6±32.3	< 0.001
HR (Beats/minute)	78 ± 10	76 ± 10	81 ± 8	0.092

Table 1 shows that obese individuals, left atrial diameter and deceleration time were significantly increased (P < 0.01). Subgroup analysis showed significant differences among the overweight and obese subgroups for these variables. The values of E,A, and E/A ratio, were similar in all the three subgroups.

Table (2): Indices of diastolic function

	Normal weight(N= 58)	Overweight (N= 77)	Obese (N= 40)	P value (Overall)
E(cm/s)	77.4 ± 13.5	77.9 ± 14.5	79. ± 15	0.85
A(cm/s)	52.5 ± 9.8	56.5 ± 10.2	58 ± 12.2	0.57
E/A	1.52 ± 0.3	1.42 ± 0.5	1.34 ± 0.2	0.16
DT(ms)	173.5 ± 13.7	190 ± 19.3	201.2 ± 24	< 0.01
LAD(cm)	2.8 ± 0.42	3.2 ± 0.4	3.5 ± 0.42	< 0.01

Table 2 shows that P-values were significant in both sexes, but in males more significant than females.

Table (3): Diastolic dysfunction according to BMI in both males and females.

Gender	Normal N. (%)		Overweight N.(%)		Obese N.(%)		P-value
Males	42 (24)		46 (26.3)		19 (10.9)		0.005
	DD Present	Absent	DD Present	Absent	DD Present	Absent	
	2(4.8)	40(95.2)	10(21.7)	36(78.3)	9(47.3)	10(52.7)	
Females	16 (9.1)		31(17.7)		21(12)		0.041
	DD Present	Absent	DD Present	Absent	DD Present	Absent	
	0(0)	16(100)	5(16.1)	26(83.9)	8(38)	13(62)	
Total	58 (33.1)		77 (44)		40 (22.9)		0.030
	DD Present	Absent	DD Present	Absent	DD Present	Absent	
	2(3.4)	56(96.6)	15(19.5)	62(80.5)	17(42.5)	23(57.5)	

Table (4): The correlations between clinical variables and left ventricular function

Variable	BMI	Age
E	0.06	- 0.26
A	0.03	0.28
E/A	0.02	- 0.37
DT	0.33	0.16
LAD	0.44	0.35

Table 4 shows the facts among the indices of diastolic function, BMI correlated positively with left atrial diameter (R-value= 0.44) and deceleration time (R-value= 0.33). Similarly, age correlated positively with left atrial diameter (R-value = 0.35) and negatively with E (- 0.26) and E/A (- 0.37). As shown in Table 4

DISCUSSION:

Obesity and overweight are the most common nutritional disorders worldwide· In the present study we have made an attempt to assess the effect of different grades of obesity on the left ventricular diastolic function. Diastolic dysfunction is an abnormality in the left ventricle and /or compliance that alter the ease with which blood flows into the left ventricle during diastole [16]. Diastolic dysfunction is age dependent, increasing from <15% in middle aged individuals to >40 % in elderly persons[17]. Our overweight and obese subjects showed alterations in the left ventricular diastolic function that were more frequent with increasing obesity. The association of these indices with obesity reported in previous studies have been variable. In the current study the results showed that E, A and E/A values did not differ across the spectrum of obesity and this agree with a study was done in Spain by Pascual et al. to 48 obese persons and 25 non obese subjects with range age (14-54 years), found the E, A, and E/A ratio did not differ[18]. Also in concordance with another study was done in Egypt by Walaa F. et al. to 65 individuals with isolated obesity, and 20 non obese, found no significant difference between individuals regarding E velocity, A velocity, and E/A ratio[19]. Across sectional study was carried out in Nineveh-Iraq by Amjad Fawzy et al. to 146 individuals from both sexes(85 male and 61 female) aged 20-59 years, observed a significant decrease in both maximum velocity of passive mitral filling (E) and E/A ratio, and increasing in the A wave[20]

Bello and colleagues in Italy, found increasing in the A wave, decreasing in the E/A ratio and no change in the E wave in 48 persons(11 males, 37 females) all without a history of medical disease[21].In the present study p-values were significant in both sexes, but in males more than females. Contrary to the current study, another study was done by Giovanni et al. in the united states to show the differences in relations between BMI in 1068 men and 1851 women and left ventricular function, found obesity influences left ventricular function substantially more in women than in men, possibly due to different in sample size[22].

In this study, the deceleration time of the mitral valve was significantly prolonged in obese subjects and correlated inversely with BMI which is in accordance with a study was done in India to show the diastolic dysfunction in individuals with isolated obesity by Praveen Kumar, et al. to two hundred subjects in the age group of 21-61 years,[23]and disagree with Pascual et al.[18] **,** while a study in Egypt by Ahmed Shalaby et al. found no statistical difference in deceleration time[24]**.**Moreover, the results showed that LAD increases significantly with BMI and agree with a study was done in Brazil by Isaura et al.[25]**,** also Walaa F. et al., observed the obese participants had significantly increased left atrial diameter[19]. Amjad et al, [20], and agree with this results. Increasing of left atrial diameter due to chronic volume overload and possibly left ventricular diastolic abnormalities.

STUDY LIMITATION:

This study was a cross sectional and the studied population size was limited. Investigation of cytokines, leptin, and renin-angiotensin-aldosteron system activity could have added information about the underlying mechanism.

CONCLUSION:

Subclinical left ventricular diastolic dysfunction was noted in all grades of obesity which correlates with body mass index, and more significant in males than females.

RECOMMENDATION:

Obese & overweight need cardiac assessment & encouragement in weight reduction regimen

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