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The Impact of Obesity on the Left Ventricular Ejection Fraction Using Echocardiography

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Abstract

Global left ventricle chamber function in obese patients is assessed, most commonly, by means of the ejection fraction. The preferred noninvasive modality for evaluating regional wall motion and overall ventricular performance is usually color-flow Doppler transthoracic echocardiography. The aim of this study was to evaluate the relationship of left ventricular ejection fraction to body mass index (BMI) measure of obesity in obese patients by using echocardiography. A prospective cohort study was conducted in the period of July 2012 to September 2014 in the ultrasound department of the Sudan Heart Center in Khartoum-Sudan, among a group of 250 obese participants of acute myocardial infarction (AMI) (67.2% males and 32.8% females) and their ages range from 22 to 86 years; mean age of 41 ± 1.2 years. Echocardiography studies were performed using MyLab 50 XVision-Esaote echocardiography machine equipped with 2.5 MHz phased array probe. Standard Statistical Package for the Social Sciences (SPSS) was used to analyze the results. The mean BMI was 28.6 ± 5.4 kg/m^2. Significant relationship is found between left ventricle ejection fraction and BMI ($P < 0.001$). BMI is a useful statistical tool to track the body size trends in a multicentric population in Sudan. Left ventricular ejection fraction allows ventricular function to be assessed without the need for further body size adjustment.

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Keywords

Acute Myocardial Infarction (AMI), Body Mass Index (BMI), Echocardiography, Ejection Fraction

1. Introduction

Acute myocardial infarction (AMI) is the most common contributor of morbidity and mortality worldwide [1]. Overweight and obesity have become increasingly common; worldwide, at least 1.1 billion adults are overweight and 312 million are obese, when overweight and obesity are defined conventionally as having a body mass index (BMI) of 25 kg/m^2 and 30 kg/m^2, respectively [2]. Surprisingly, obesity is a chronic disease that is often neglected and frequently not even thought of as a serious, life threatening condition [3] [4].

In general, population, overweight and obesity are associated with increased risk of developing cardiovascular disease, and thus it is not surprising that in cohorts of patients with the prevalent ischemic heart disease or acute coronary events, well over 50% are overweight or obese [5]-[8]. This relation could be due to the higher prevalence of diabetes, hypertension, and hypercholesterolemia observed in obese patients, but these data are derived mainly from high income countries. Although most of the global burden of cardiovascular disease is in developing countries, few data are available for the effect of obesity in these populations [9]-[11].

The diagnosis of an AMI is typically based upon the history, electrocardiogram, and cardiac enzymes, particularly serum troponins and creatine kinase fraction. Although not routinely performed for diagnosis, echocardiography is an accurate, noninvasive test that is able to detect evidence of myocardial ischemia or necrosis [12] [13].

The left ventricular ejection fraction after AMI is an important marker for mortality [14] [15]. The left ventricular ejection fraction may be assessed by nuclear imaging, magnetic resonance imaging and echocardiography [16]-[18]. Nuclear imaging and magnetic resonance imaging provide relatively reliable information and with acceptable intra and inter observer variability [19] [20]. However, the use of these imaging modalities is limited by radiation exposure during nuclear imaging, high costs and non availability in the coronary care unit and catheterization laboratory. Echocardiography is currently the most frequently used imaging modality for the assessment of left ventricular ejection fraction [17].

This study was designed with an aim to evaluate the relationship of left ventricular ejection fraction to body mass index (BMI) measure of obesity in obese patients using echocardiography.

2. Materials and Methods

2.1. Study Design and Population

This prospective cohort study was performed in the period of July 2012 to September 2014. Participants were scanned in the ultrasound department of the Sudan Heart Center in Khartoum, Sudan. Prior to participants scanning, a formal approval was obtained from Ethics and Scientific Committee of Sudan Heart Center and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and all subsequent revisions. After the nature of the procedure was fully explained, informed consents were obtained from participants and the ultrasound department.

Extensive medical history, detailed physical examination and measures of body mass index (BMI) were performed for each participant. Participants were included on the basis that they were positive to left ventricular systolic dysfunction with an ejection fraction of (≤ 40%) determined by echocardiographic assessment of left ventricular function. Hypertension, impaired glucose tolerance/diabetes, dyslipidemia and previously treated from AMI surgically participants were excluded.

2.2. Technical Information Identifies

Echocardiography studies were performed using MyLab 50 XVision-Esaote echocardiography machine equipped with 2.5 MHz phased array probe, with small footprint for peeking in between rib interspaces. A water soluble gel was used to produce airless contact between the transducer and the patient's chest. Printing facilities issued through digital graphic ultrasound printer (made by Sony Corporation, Japan), 100 V; 1.5 A; and 50/60

Hz.

2.3. Cardiac Ultrasound Scanning Techniques

While the patient is in the recumbent position, the transducer was placed in the fourth intercostal space at the left sternal border and directed posteriorly, laterally, and inferiorly to obtain a group of strong echoes from the posterior left ventricular wall. These echoes were recognized by their characteristic motion anteriorly during ventricular systole and posteriorly during diastole [19] [20].

Left ventricular systolic function was assessed by calculation of the wall motion index (WMI). An estimate of left ventricular ejection fraction can be obtained by multiplying the wall motion index by 0.3. In the present study, significant left ventricle systolic dysfunction was defined as WMI ≤ 1.4 (left ventricle ejection fraction approximately ≤ 40) [21].

2.4. Statistical Analysis

Data were initially summarized as mean ± SD in a form of comparison tables. Statistical analysis was performed using the standard Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 15 for windows. *P*-value terms such as equal and less to be used for significance; *P*-value ($P < 0.001$) was considered to be significant.

3. Results

Study population comprised 250 obese participants (67.2% males and 32.8% females). Participants' ages ranged from 22 to 86 years; with a mean age of (41 ± 1.2) years (**Table 1**).

Out of the examined participants, a total of 93 subjects (58 males and 35 females) were presented in the age group (70 - 86) years, representatives (37.2%) of the population (**Table 2**). The age group of (50 - 59) years was the smallest and represented only (10.8%) of the population (**Table 2**).

The mean BMI among participants was 28.6 ± 5.4 kg/m^2 (**Table 3**). At (22.8%) of participants BMI was >19 and < 25 kg/m^2, (36%) had a BMI of > 25 and < 30 kg/m^2, (24.4%) showed BMI of > 30 and < 35 kg/m^2 and (16.8%) had a BMI > 35 kg/m^2 (**Table 3**).

The relation between BMI and left ventricle ejection fraction among obese participants was presented in (**Table 4**), where the obtained *P*-value shows a significant relationship between obesity and left ventricular ejection fraction (**Table 4**).

Table 1. Gender and age of participants.

Variable	Age Range (years)	Mean ± SD (years)	Percentage (%)
Age	22 - 86	41 ± 1.2	100
Variable	Male	Female	Percentage (%)
Gender	168	82	100

Table 2. Distribution of participants age (years).

Age Ranges	Gender		Total	Percentage (%)
	Male	Female		
22 - 39	24	5	29	11.6
40 - 49	24	9	33	13.2
50 - 59	17	10	27	10.8
60 - 69	45	23	68	27.2
70 - 86	58	35	93	37.2
Total	168	82	250	100

Table 3. BMI ranges, frequency, percentage and mean ± SD among participants..

BMI (kg/m^2)	Frequency	Percentage (%)	Mean ± SD
>19 and <25	57	22.8	21.60 ± 1.7
>25 and <30	90	36.0	26.97 ± 1.7
>30 and <35	61	24.4	31.98 ± 1.4
>35	42	16.8	36.92 ± 1.9
Total	250	100	28.60 ± 5.4

Table 4. Left ventricular ejection fraction and BMI relationship.

Ejection Fraction (%)	BMI (kg/m^2)	*P*-Value
≤40.02	>19 and <25	<0.001
≤41.2	>25 and <30	<0.001
≤42.08	>30 and <35	<0.001
≤43.08	>35	<0.001

4. Discussion

The results of this study indicate that obesity is positively related to increase the ejection fraction of the left ventricle (**Table 4**). Obesity has been considered as a state of chronic volume overload because the heart is required to circulate blood through the large and relatively low resistance depot of adipose tissue. Early studies had suggested that obesity was associated with eccentric left ventricular remodeling. The results of cine cardiac magnetic resonance (CMR) study and other echocardiography studies instead now consistently show that both left ventricular cavity size and wall thickness may be increased in obese subjects with wall thickness increased to a greater extent than cavity size (concentric left ventricle remodeling) [22] [23]. Several studies have found that the left ventricle ejection fraction is normal to increase in the majority of obese subjects [22]-[24].

Iacobellis and Sharma [25] proposed uncomplicated obesity as those individuals with elevated BMI but with normal fasting glucose, glucose tolerance, systolic and diastolic blood pressures, lipid profile, resting electrocardiogram, and thyroid function, without a history of metabolic, cardiovascular, respiratory disease, and clinically significant abnormalities on physical examination. They reported that indexed left ventricle mass and left ventricular geometry in subjects with uncomplicated obesity (n = 75) were not significantly different from a lean control group (n = 60) [24]. In the present study, all participants were obese and without hypertension, impaired glucose tolerance/diabetes and dyslipidemia. Therefore, the concept of uncomplicated obesity was not useful in our study population due to the rare occurrence of this phenotype.

Determining the relationship between obesity and cardiac size is confounded by the known positive relationship of body size to left ventricular mass and volume. Body surface area is the most common index for cardiac size, but has been suggested to underestimate the impact of obesity on left ventricular mass and geometry [26]. Alternatively, indexing left ventricle mass to the 2.7 power of height has been reported to be appropriate for but has unknown applicability for CMR. For the Multi-Ethnic Study of Atherosclerosis (MESA) population, left ventricle mass indexed to the 2.7 power of height resulted in a higher proportion of left ventricle hypertrophy for shorter participants compared with taller participants [27], raising questions regarding the validity of this approach to our data (**Table 3** and **Table 4**).

As a limitation, the authors didn't overcome this difficulty, because we looked at single measures of obesity by using body BMI, rather than other measures of obesity as waist circumference (WC), waist-to-hip ratio (WHR) and measures the association of fat mass (FM) with left ventricle size after controlling for fat-free mass.

5. Conclusion

In conclusion, BMI shows a significant association with myocardial infarction risk. BMI is a useful statistical tool to track the body size trends in Sudan. Left ventricular ejection fraction allows ventricular function to be assessed without the need for further body size adjustment. With BMI measures of obesity, ejection fraction showed a consistent change in relation to increased obesity levels.

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