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Gated-SPECT Functional Assessment in Overweight and Obese Patients

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Abstract

Introduction: Obesity could be implicated in the modification of myocardial structure and function. Mexico has a 70% prevalence of overweight/obesity; therefore, we suggest assessing these changes with a non-invasive technique as the Gated-SPECT.

Methods: This is retrospective observational study. Gated-SPECT assessment was conducted in patients suggesting ischemic heart. Multiple regression analysis was used for predicting the value of age, sex, BMI, DM and hypertension for functional parameters. T-test was used to compare DM groups and one-way ANOVA to compare BMI groups.

Results: The model statistically significantly predict BMI and smoking to contribute to the prediction of LVEF, $p<0.005$, adj. $R^2 = 0.155$. BMI, sex and hypertension added statistically significantly to the EDV prediction, $p<0.05$. EDV, $p < 0.005$, adj. $R^2 = 0.202$; and sex, age and hypertension to the ESV prediction, $p<0.005$, adj. $R^2 = .251$. Significant differences between men and women groups in ESV and EDV were found, $p<0.000$.

Conclusions: BMI is associated with the decrease in LVEF and the elevation of EDV without ventricular dysfunction. Sex, age and hypertension counted for predictors for an increase in ESV. There were no significant differences in the diabetic and non-diabetic groups, however obese diabetic patients have an increase in their EDV values. These alterations could be secondary to preliminary changes in left ventricular remodeling. Gated-SPECT is an effective non-invasive technique to discover alterations in structures before fatal events.

Keywords: Left ventricular parameters; Obesity; Gated-SPECT

Introduction

A wide range of scientific material shows evidence that obesity is associated with cardiovascular risk factors such as hypertension, diabetes mellitus, insulin resistance and dyslipidemia [1-3]. It has also been proved that obesity could be implicated in the modification of myocardial structure and function [4,5] which may normalize wall stress while increasing stroke volume to match metabolic demand. As a result, there is an increase in both preload and afterload due to a hyperdynamic circulation, chronic volume overload, and increase in peripheral resistance [5,6]. Thus, both end systolic volume (ESV) and end diastolic volume (EDV) abnormalities, are associated with obesity as well [7].

For some years the relation between the left ventricle ejection fraction (LVEF) and the continuum of body mass index (BMI) was poorly explained. Recently, some studies have proved that it is possible that the left ventricle dilates with greater BMI, but left ESV may ensue only with severe degrees of obesity [8]. However, a study demonstrated that subclinical signs of left ventricular diastolic function impairment are present in overweight subjects too, and that these abnormalities are independent of associated risk factors [5].

Obesity has been associated with left ventricular hypertrophy and dilatation, which are known precursors of heart failure [9-11]. Nonetheless, other studies have reported that in obese patients with no clinically significant obstructive coronary artery disease or valvular disease, no LVEF alteration is present [12].

Several lines of evidence from experimental and clinical studies suggest that diabetes mellitus (DM) has an adverse impact on the heart. Left ventricular dysfunction has been strongly associated with diabetes mellitus [13]. There is also evidence suggesting that patients who have type II diabetes but no clinically apparent heart disease have impaired function of the left ventricle both in ESV and EDV in both at rest and peak stress [14]. In another study it was found that absolute and indexed LV mass values were higher in diabetic than glucose-tolerant patients [15].

Structural and hemodynamic changes may occur in a subclinical form in this type of population. Despite the prevalence of 70% of obesity and overweight in Mexican population [16], little progress has been made in the investigation of the impact of these changes as a consequence for heart failure. Therefore, there is need to study changes in ventricular function, hemodynamic and subclinical repercussion of structural remodeling in obese patients. Our objective was to determine the left ventricular functional parameters (LVEF, EDV, ESV) in overweight and obese patients with and without other associated cardiovascular risk factors, evaluated with Gated-Myocardial Perfusion Single-Photon Computed Tomography (g-SPECT) [17].

Methods

From the Nuclear Medicine department´s computerized data base, we selected patients who were referred to a Gated-SPECT assessment as part of the study protocol presenting symptoms such as chest pain, chest sting and/or angina; suggesting ischemic heart. From June 2008

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to May 2012 we found 137 patients. Exclusion criteria included valvular disease, dilated or hypertrophic or myocardiopathy were excluded. Clinical characteristics as age, gender, height, weight and risk factors as hypertension (defined as systolic blood pressure ≥ 140 mmHG and diastolic pressure ≥ 90mmHg [18]), dyslipidemia (cholesterol levels above>200 mg/dl and c-ldl > 160 mg/dl [19], diabetes (A1C ≥ 6.5% or fasting plasma glucose ≥ 126 mg/dL [20]) and smoking were asked before the assessment as part of their clinical history.

Gated-myocardial perfusion single-photon computed tomography (Gated-SPECT)

All 137 patients underwent rest Gated-SPECT myocardial perfusion imaging protocol, with Tc^{99m} tetrofosmin, for evaluation of ventricular function parameters: EDV, ESV y LVEF. Data were systematically assessed using a commercially available software package, Emory University/Syntermed, Atlanta, Georgia, USA) [18].

Statistical analysis

DM groups were compared using a t-test for continuous variables. For the three groups based on BMI classification, one-way ANOVA was used. For each of the three assessed parameters values, a multiple linear regression analysis was run in order to find the statistical significance of the overall model and each predictor variable as well as the measure of effect size. A p value <0.05 was considered statistically significant.

Results

Continuous variables are described by the mean value (M) ± standard deviation (SD). Data on individual and clinical characteristics, as well as common cardiac related symptoms, are summarized in Table 1. Women represent 67.6% and men 32.4% from the total sample, mean age was 63 ± 11 years. From all 137 patients 71.9% were hypertensive, 37.9% had elevated triglycerides levels, 35.3% smokers, 35% had dyslipidemia, and 33.8% were diabetic. The most common symptom was typical angina (defined as the presence of substernal or precordial chest pain or discomfort) reported by 85.5%, second was equivalent dyspnea (difficult or labored breathing; shortness of breath) 18.3%, and the less common reported symptom was angina-like chest pain (pain or discomfort) 7.8%.

Myocardial perfusion was normal in all patients. All findings were stratified by sex, divided into diabetic and non-diabetic groups, and classified based on BMI as obese (BMI≥30), overweight (25≤BMI<30), and normal weight (BMI<25) as shown in Table 2. From the total sample, 42.76% were overweight, 31.1% were obese and 26.21% had normal weight.

We observe significant differences within the BMI classification groups for EDV values (Table 2). In addition, ESV increased from the normal weight (M=18.6, SD=9.8, p=NS) to the overweight group (M=24.9, SD=19.5 p=NS), and to the obese group (M=28.1, SD=21.2 p=NS). LVEF remain almost the same for the three BMI groups. However, there was a significant difference in LVEF associated to sex, where women had a higher percentage. In addition, comparisons trough the independent-samples t-test between sex groups revealed significant differences: scores of EDV were significantly higher in men (M=89 SD=40.6 p>.000) than in women (M=64.4, SD=27.9, p>.000) (Table 3). Similarly, values of ESV were higher in men (M=36.9, SD=24.3, p>.000) compared to women (M=191.7, SD=12.4, p>.000). Table 4 depicts that our results do not count for significant differences between diabetic and non-diabetic groups.

Despite the fact that we did not found significant differences, Figure 1 clearly shows a higher percentage of LVEF in the normal weight diabetic patients. Figure 2 show that patients in the obese group had a lower mean percentage in this parameter. EDV values were higher in men of the three BMI classification groups compared to women of the same groups (Figures 3 and 4). Turning to DM groups, no differences were identified between these groups; nevertheless, an increase from each BMI classification group is seen. Regarding ESV, a higher increase was found as shown in Figure 5, whilst no differences were found in the DM groups´ means (Figure 6).

In order to adjust for possible cofounders we run a multiple

Variable	n=137
Sex (male/female)	43/94
Age	63 ±11
Weight (Kg)*	71.8 ±14.96
Height (m)*	1.58 ±.09
IMC*	28.67 ± 5.88
DM (yes/no)	43/94
HAS (yes/no)	99/38
Triglycerides (yes/no)	51/86
Smoking (yes/no)	48/89
Symptoms	
Typical angina (yes/no) Equivalent dyspnea (yes/no)	36/101 23/114
Anginalike chest pain (yes/no)	51/86
Functional Parameters*	
LVEF Stress	68.8 ± 11.2
EDV Stress	74.22 ± 33.8
ESV Stress	24.19 ± 18.2

Table 1: Clinical characteristics and findings.

	Normal Weight (BMI<25.0 kg/m^2) (n=38)	Overweight (BMI 25.0–29.9 kg/m^2) (n=62)	Obese (BMI >30.0 kg/m^2) (n=45)	p value
LVEF %	69.8 ± 13.9	68.5 ± 10.3	68.3 ± 9.8	0.815
EDV ml	64.6 ± 18.6	73.4 ± 31	83.8 ± 40.6	0.039*
ESV ml	18.6 ± 9.8	24.9 ± 19.5	28.1 ± 21.2	0.060

* p < 0.05
Values are mean or % ± SD. Multiple comparisons were carried out with the Bonferroni correction method.

Table 2: Functional gated-SPECT Parameters by Body Mass Index (BMI) classification.

	Women (n=94)	Men (n=43)	p value
LVEF %	70.6 ± 11.6	64.9 ± 9.1	0.005*
EDV ml	67.4 ± 27.9	89 ± 40.6	0.000*
ESV ml	19.7 ± 12.4	33.9 ± 24.3	0.000*

* p < 0.05
Values are mean or % ± SD

Table 3: Gated-SPECT parameters data by sex.

	Diabetic (n=43)	Non-Diabetic (n=94)	p value
LVEF %	68.02 ± 10.1	69.18 ± 11.7	0.577
EDV ml	73.26 ±39.5	74.66± 31	0.823
ESV ml	24.9 ±20.9	23.8 ±16.9	0.734

* p < 0.05
Values are mean or % ± SD. Multiple comparisons were carried out with the Bonferroni correction method.

Table 4: Gated-SPECT parameters in diabetic and non-diabetic groups.

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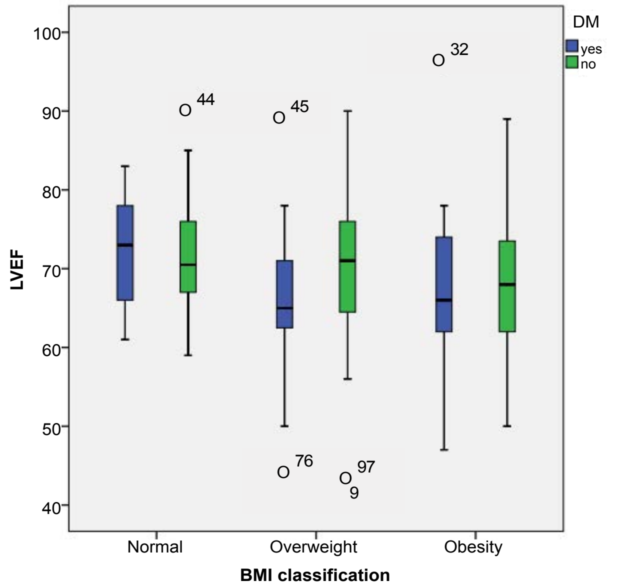

Figure 1: Left ventricular ejection fraction in each DM group and classified by BMI.

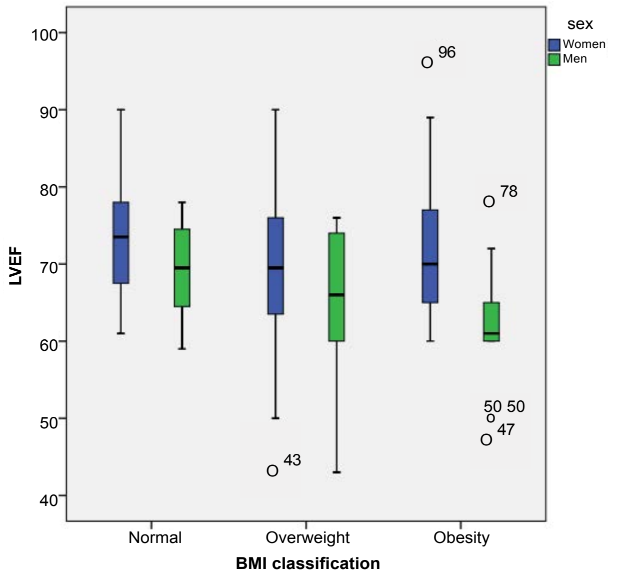

Figure 2: Left ventricular ejection fraction in each sex group and classified by BMI.

regression analyses. The assumptions of linearity, independence of errors, homoscedasticity, unusual points and normality of residuals were met in each one. Table 5 shows the summary of results where regression coefficients and standard errors can be found. The model statistically significantly predict LVEF, $F(6, 130)=3.964$ $p<0.005$, adj. $R^2=0$ .155 where only BMI and being a smoker was a significant predictive value. Table 6 indicates that sex, BMI and hypertension added statistically significantly to the prediction for EDV: $p<0$ .05. EDV, $F(6, 130)=5.448$ $p<0.005$, adj. $R^2=0.202$. Finally, Table 7 counts for ESV summary of regression coefficients where sex, age, and hypertension add predictive value to the model, $F(6, 124)=6.936$ $p<0.005$, adj. $R^2=0.251$.

Discussion

A number of studies have proved the presence of ventricular dilatation and increase in ventricular volumes secondary to remodeling in obese patients [4,5]. Our study aimed to evaluate the presence of alterations in left ventricular volumes and ventricular function in obese and/or diabetic patients assessed by Gated-SPECT. We also seek for the contribution of other variables associated to heart failure that could represent the structural changes associated to obesity in subclinical form secondary to the existent ventricular remodeling [5,7,8].

Similarly to other studies [5,14], we found a significant correlation between LVEF and EDV with BMI. The higher the body mass, the less percentage of FEVI was found. An increase in ESV values is clearly observed in the obese group (BMI ≥ 30) and in obese diabetic patients.

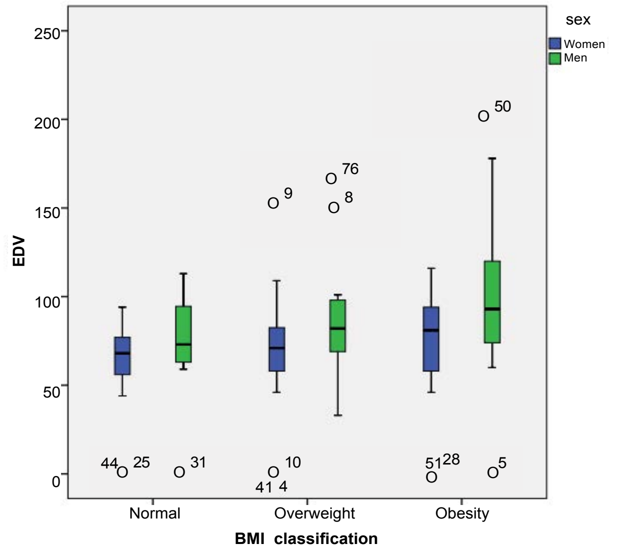

Figure 3: End-diastolic volume in each sex group and classified by BMI.

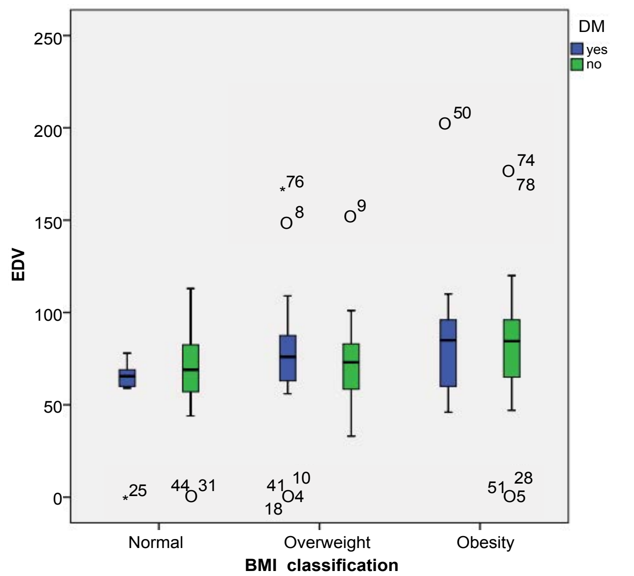

Figure 4: End-diastolic volume in each DM group and classified by BMI.

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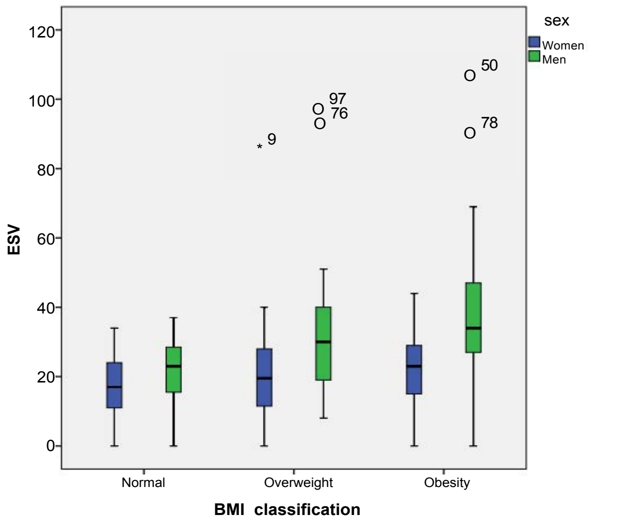

Figure 5: End-diastolic volume in each sex group and classified by BMI.

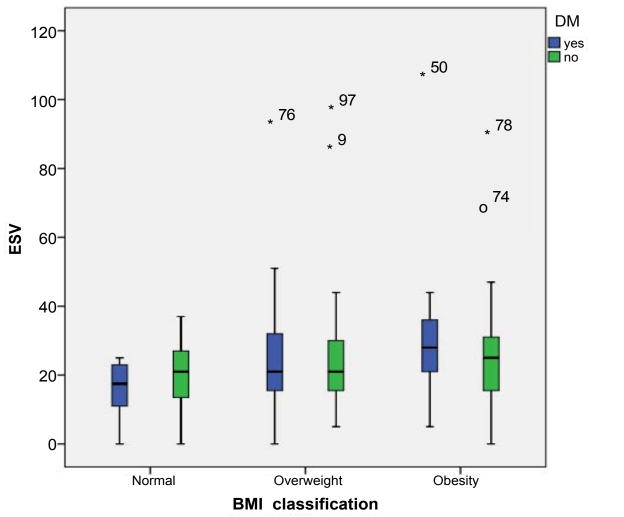

Figure 6: End-diastolic volume in each DM group and classified by BMI.

Variable	B	SE_B	β
Intercept	57.4	9.323	0.000*
BMI classification	.135	2.046	0.027*
Sex	-4.58	.083	0.825
DM	.493	1.986	0.054
Age	.018	2.004	0.806
Smoker	3.87	2.186	0.002*
Hypertension	6.866	1.235	0.913

p < 0.05; B = unstandardized regression coefficient
SE_B = Standard error of the coefficient
β = standardized coefficient

Table 5: Summary of multiple regression analysis for LVEF.

Therefore, we support the evidence that show that not only in obese but also in overweight patients, their condition alters their myocardial structure [5,9-12]. Moreover, even when presenting diabetes, our patients with normal weight maintained their LVEF percentages. Also, we identified that ETV values in obese patients increased; thus, validating hemodynamic alterations previously presented by the patients before a decrease in LVEF occurs [21,22]. Surprisingly, in contrast with the revised literature [13-15] we did not found differences when comparing DM with non-DM groups.

Statistically significant differences in EDS and ESV in both sex groups, while preliminary, suggest that men had higher values of these parameters even after adjusting for other possible cofounders. In addition, hypertension counted for a significant predictive variable for these two parameters. Therefore, being a man and hypertensive represent a higher risk for presenting alterations in ventricular volumes.

The current findings highlight that Gated-SPECT is a non-invasive imaging cardiovascular technique which improves early diagnostic capabilities and prognostic power during the subclinical stage of functional ventricular abnormalities. We also contributed to present evidence of alterations due to obesity and overweight despite other risk factors.

Limitations

We aimed to determine the relation of left ventricular functional parameters in patients classified by BMI with and without other associated cardiovascular risk factors, evaluated with Gated-Myocardial Perfusion Single-Photon Computed Tomography (g-SPECT) [17].

It could be argued that the number of patients in compared groups i.e. sex and diabetes/non-diabetes were fairly despair. Therefore, significance might be interpreted with caution. We strongly recommend the investigation of the left ventricular functional parameters in overweight and obese patients with and without diabetes increasing the number of patients in each group. Further studies might be conducted to explore differences between groups classified and consider hypertension and smoking as complementary predictive variables.

Variable	B	SE_B	β
Intercept	103.451	27.449	0.000*
BMI classification	5.589	3.620	0.027*
Sex	19.721	5.956	0.001*
DM	0.493	5.816	0.054
age	1.081	0.241	0.853
Smoker	-1.338	5.806	0.818
Hypertension	-15.586	6.367	0.016*

* p < 0.05; B = unstandardized regression coefficient
SE_B = Standard error of the coefficient
β = standardized coefficient

Table 6: Summary of Multiple Regression Analysis for EDV.

Variable	B	SE_B	β
Intercept	37.483	9.678	0.000*
Sex	7.992	2.131	0.000*
Age	-0.318	0.085	0.000*
Smoker	0.036	2.055	0.986
DM	-0.177	2.079	0.932
Hypertension	-7.133	2.248	0.002*
BMI classification	1.562	1.276	0.223

* p < 0.05; B = unstandardized regression coefficient
SE_B = Standard error of the coefficient
β = standardized coefficient

Table 7: Summary of multiple regression analysis for ES.

Conclusions

There were no significant differences in the diabetic and non-diabetic groups. Nonetheless, it could have been due to the despair number of patients in each group. BMI is negatively associated with the decrease in LVEF and the elevation of EDV without ventricular dysfunction. Sex, age and hypertension counted for predictors for an increase in ESV and EDV values. These alterations could be secondary to preliminary changes in left ventricular remodeling. Gated-SPECT is an effective non-invasive technique to discover alterations in structures before fatal events occur.

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