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Original Research Article

Comparison of Left Ventricular Mass in Obese Versus Normal BMI Patients

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ABSTRACT

Aim: The goal of the study was to assess the change in left ventricular mass in severely obese subjects as compared to normal BMI patients free of additional cardiovascular risk factors.
Methods: 40 obese and 16 normal BMI subjects without cardiovascular risk factors were recruited for the study which underwent cardiovascular magnetic resonance imaging for assessment of left ventricular mass and left ventricular volumes. Left ventricular mass was then compared to markers of obesity linked to left ventricular mass, i.e. height, age, blood pressure, total fat mass, lean mass and BMI.
Results: Obesity was associated with significantly increased left ventricular mass ($p < 0.001$). Age, height, BMI, total fat mass and lean mass are found to be strongly associated with left ventricular mass.
Conclusion: Independent link between obesity and left ventricular hypertrophy have potentially important prognostic and therapeutic implications for prevention of cardiovascular risk.
Keywords: Left ventricular mass, obesity, BMI

INTRODUCTION

In obese patients, Left ventricular hypertrophy is one of the important characteristic cardiac adaptations. [1] The evidences for the relationship of left ventricular hypertrophy and mortality is growing. The increased prevalence of obesity suggests the fact that obesity is associated with an increased risk of death. [2,3] Obesity could be a concern of clinical importance as it can modulate cardiovascular risk. Therefore, it become important to identify the determinants of obesity influencing left ventricular mass for prognosis and therapeutic intervention aimed at primary and secondary prevention.

The mechanisms responsible for left ventricular hypertrophy have stayed the focus of many research studies and it has been identified that multiple clinical parameters are associated with left ventricular mass including age, systolic blood pressure, body size, BMI and both visceral and free fat mass. [4] Majority of previous studies have investigated that obesity when associated with related co-morbidities of hypertension, diabetes and hypercholesterolemia are known to have an independent effects on the cardiovascular system.

In obesity, due to increased metabolic demands both cardiac output and total blood volume are elevated. These circulatory changes causes remodeling of left ventricular geometry in the form of cavity dilatation which is a structural change commonly seen in obesity leading to compensatory left ventricular hypertrophic response in response to increased wall stress. [5,6] The present study aimed to compare the left ventricular mass in obese and normal patients.

In the present study we have used cardiovascular magnetic resonance (CMR), which yields accurate and reproducible measurement of left ventricular mass, regardless of the amount of chest wall fat, [7] and these measurements are related to age, height, body surface area, BMI, visceral fat mass, total fat mass and lean body mass.

METHODOLOGY

A total of 40 healthy obese subjects (BMI > 30 kg/m2, 11 male, 29 female) and sixteen normal weight subjects

(BMI 18.5 – 24.9 kg/m2, 6 male, 10 female) were recruited for the study. Cardiac risk factors in all subjects were screened and the participants were excluded if they had a history of cardiovascular disease, hypertension, diabetes, current smoking, or use of cardiac medications. The participants were excluded if they had an elevated fasting glucose level (≥ 6.7 mmol) or a fasting total cholesterol level ≥ 6.5 mmol, a history of coronary artery disease, or of cardiac chest pain or valvular heart disease, obstructive sleep apnoea.

Age, height and BMI were recorded of each patient and subjected to data analysis.

Body Composition analysis

Bio-electrical impedance (Bodystat ©1500 analyzer) was used to assess total body fat mass and lean body mass. Bio-electrical impedance analysis records the impedance or opposition to the flow of an electric current through the body fluids contained mainly in the lean and fat tissue. Impedance is recorded low in lean tissue, where intracellular and extracellular fluid and electrolytes are primarily contained, but high in fat tissue. Impedance is thus proportional to body water volume. A small 400 uA current at 50 kHz, was passed between electrodes spanning the body which provide the measurement of impedance. Lean body mass is then calculated from this estimate using an assumed hydration fraction for lean tissue. Total fat mass is calculated as by subtracting body weight and lean body mass.

Waist: hip ratio is calculated by the average of measurements recorded at a) the level of the umbilicus and b) the level of the greater trochanter of the femur.

Cardiovascular resonance imaging (CMR)

The assessment of left ventricular mass, volumes, ejection fraction and aortic distensibility were performed on CMR by a 1.5 Tesla MR system (Siemens Medical Solutions, Erlangen, Germany) as previously described. [8] All imaging was prospectively cardiac gated with a precordial four lead ECG and acquired during end expiratory breathold. Cardiac cine images were attained using a steady state free precession (SSFP) sequence with an echo time (TE) of 1.5 ms, a repetition time (TR) of 3.0 ms, temporal resolution 47.84 ms and a flip angle of 60°.

Following localization images, an SSFP cine short axis stack of contiguous images was obtained with a slice thickness of 7 mm and an interslice gap of 3 mm, as previously explained. [9,10]

Data measurement

Left ventricular volumes and mass was performed for image analysis using Siemens analytical software (ARGUS©) as described. [9] The short axis stack was analyzed manually contouring the endocardial borders from base to apex at end-diastole and end-systole. The epicardial border was contoured at end-diastole to yield myocardial mass. Left ventricular mass (g) were calculated as difference of the epicardial volume and endocardial volume multiplied by 1.05 (specific gravity of myocardium). Cardiac output (l/min) was calculated as left ventricular stroke volume (ml) × heart rate (bpm).

Statistical Analysis

Data were tabulated and examined using the Statistical Package for Social Sciences Version 20.0 (IBM SPSS Statistics for Mac, Armonk, NY: IBM Corp, USA). Descriptive statistical analysis had been carried out in the present study. Results on continuous measurements are presented as Mean±SD. The statistical power calculation was based on the assumption that the data were normally distributed. Unpaired student T test was used to determine the significant difference between the groups and level of significance i.e. p was set at <0.05. Obese and normal weight groups were matched as groups, not as pairs. To assess the major determinants of left ventricular mass, a stepwise multiple linear regression model was performed.

RESULTS

Normal controls and obese subjects were well matched for age, height, systolic blood pressure, diastolic blood pressure, with no significant differences between obese and normal weight individuals. Waist hip ratio, total fat mass and lean mass which were all higher in the obese group (Table 1).

Left ventricular mass and end-diastolic volume was both higher in the obese group when compared to the normal weight group. End-systolic volume, stroke volume and cardiac output were also elevated in obesity. Left ventricular ejection fraction was comparable in normal weight and obese subjects (Table 2).

Total fat mass, lean mass, waist hip ratio and BMI were found to have a significant positive relationship with left ventricular mass. Height and age were found to have positive relationships with left ventricular mass. Neither systolic nor diastolic blood pressure were related to left ventricular mass in normotensive study population. (Table 3)

On simple linear regression, left ventricular end-diastolic volume, end-systolic volume, stroke volume and cardiac output were found to be associated with left ventricular mass. Left ventricular ejection fraction was not found to be related with left ventricular mass (Table 3)

Table 1: Anthropometric results for the study population

Parameters	Normal weight subjects (16)	Obese subjects (40)	p value
Age (years)	45±12	41±14	0.09#
Height (m)	1.62±0.04	1.60±0.02	0.49#
Weight (kg)	63±8	108±16	<0.001*
BMI (kg/m^2)	22.4±1.2	39.7±7.2	<0.001*
Systolic Blood pressure(mmHg)	118±7	122±12	0.28#
Diatolic Blood pressure(mmHg)	76±6	77±7	0.19#
Waist:Hip ratio	0.79±0.07	0.91±0.07	<0.001*
Total fat mass(Kg)	21±8	49±18	<0.001*
Lean fat mass (Kg)	48±6	61±6	<0.001*

Table 2: Left ventricular characteristics of the study population

Features	Obese subjects (N=40)	Normal weight subjects (N=16)	p value
Left ventricular mass (g)	125±32	89±23	<0.001*
Left ventricular End diastolic volume (ml)	151±22	115±19	<0.001*
Left ventricular End systolic volume (ml)	48±12	36±12	<0.001*
Left ventricular stroke volume (ml)	109±17	81±13	<0.001*
Left ventricular ejection fraction (%)	71±7	70±6	0.71
Cardiac output (ml)	6.4±0.89	4.9±1.1	<0.001*

Table 3: Linear regression analysis for left ventricular mass

Parameters	R^2	β	F	p value
Age (years)	0.118	0.35	6.8	0.014*
Height (m)	0.167	0.51	11.8	0.001*
BMI (kg/m^2)	0.224	0.54	18.8	<0.001*
Systolic Blood pressure(mmHg)	0.056	0.24	2.9	0.001*
Diatolic Blood pressure(mmHg)	0.054	0.25	3.0	0.08#
Waist:Hip ratio	0.289	0.54	20.9	<0.001*
Total fat mass(Kg)	0.165	0.37	9.1	0.003*
Lean fat mass (Kg)	0.699	0.86	120.9	<0.001*
Left ventricular End diastolic volume (ml)	0.512	0.68	52.3	<0.001*
Left ventricular End systolic volume (ml)	0.148	0.41	9.6	0.003*
Left ventricular stroke volume (ml)	0.529	0.71	57.8	<0.001*
Cardiac output (ml)	0.234	0.50	16.8	<0.001*

DISCUSSION

The present study was performed to examine the factors influencing left ventricular mass in a severely obese population without additional co-morbidity and any cardiovascular risks. In accordance with the previous studies, the present study has depicted similar results that obesity is associated with elevated left ventricular mass, cavity dilatation and increased cardiac output.

The various factors of left ventricular hypertrophy in the general population has been elucidated by multiple research studies but very few investigations have studied the association of left ventricular mass with obesity without the confounders of obesity related comorbidities.

Previous investigations by Savage et al. [11] and Kuch et al. [12] age, height, systemic arterial hypertension, and body size were been found to be the main factors affecting of left ventricular hypertrophy. Silva et al. [13] stated that when obesity with comorbidities were studied insulin resistance, abdominal adiposity, systemic arterial hypertension, and lean mass have previously been shown to be the factors associated with left ventricular mass.

In the present study, it has been stated that age and height were found to be positively associated with left ventricular mass in obese patients without co morbidities. BMI and waist hip ratio was found to be strongly associated with left ventricular mass in overweight patients. Total fat mass and lean fat mass are found to be associated with left ventricular mass in an obese population without additional cardiovascular risk factors and co-morbidity. This could be justified by the fact increased body size due to increased fat mass could cause increase in skeletal muscle mass to compensate for the additional physical demand of gained weight.

According to Kupari et al. [14] left ventricular stroke volume has been found to be a major predictor of left ventricular mass in patient groups including hypertensive and overweight subjects. In the present study, it was revealed that stroke volume is a determinant of left ventricular mass in obese individuals in normotensive patients. It can be explained by the fact that increased wall stress imposed by cavity dilatation increasing stroke volume could result in hypertrophic response of the left ventricle. [15] The present study has revealed that both end diastolic volume and stroke volume are strongly associated with left ventricular mass on simple linear regression.

CONCLUSION

Obesity has been found to cause increased mortality. The mechanisms behind this are not clearly explained but possibly may be related to elevated left ventricular mass. As result of this, identification of the factors affecting left ventricular mass in obesity has implications for prognosis and therapeutic intervention aimed at reducing mortality.

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