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Research Article

ASSESSMENT OF MYOCARDIAL MECHANICS IN YOUNG OBESE ADULT STUDENTS

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ABSTRACT

Obesity is one of the most common disorders of metabolism in human beings having increasing prevalence in both developed and developing countries. The dramatic increase in the prevalence of obesity and its strong association with cardiovascular disease world over has resulted in unprecedented interest in understanding the effects of obesity on the cardiovascular system. From the present study we concluded that in young overweight and obese adult subjects systolic function was rather improved but none of these subjects were having diastolic dysfunction except IVRT on echocardiography. There were no significant ECG changes as far as cardiovascular physiological parameters are concerned. Our data was derived from young healthy adults and thus cannot be applied generally for all age groups even if individuals are healthy but study can definitely provides a foundation for future studies in pathological conditions. However, there is scope for further studies, like a prospective study can be undertaken in the same subjects after some more time to know any further change in cardiovascular physiological parameters in long standing obesity. Furthermore, a gender specific different age groups study in long standing obesity can also be undertaken for more clarity.

INTRODUCTION

Obesity is one of the most common disorders of metabolism in human beings, it being a chronic, progressive disease with increasing prevalence in both developed and developing countries. It represents an independent risk factor for hypertension, diabetes mellitus, dyslipidemia, and cardiovascular diseases (1, 2). Obesity in young otherwise-healthy women is associated with concentric LV remodeling and decreased systolic and diastolic function that may have important implications for explaining the myocardial dysfunction leading to increased cardiovascular morbidity and mortality (3). The prevalence of obesity in US and other countries has increased significantly (4). In India also, it has emerged as independent risk factor for the development of heart failure (3). Long standing obesity from young adulthood to middle age is associated with impaired LV systolic and diastolic function (5) and early detection of subclinical pathological cardiac changes shall influence the initiation of treatment and prevention of heart failure (2).

Obesity increases cardiac workload by increasing total blood volume and cardiac output. In long standing obesity many studies have authenticated eccentric LV hypertrophy, LV diastolic dysfunction, and occasionally LV systolic dysfunction (6,7,8). Impairment of cardiac function has been reported to correlate with degree of obesity i.e. body mass index (BMI) and duration of obesity (7,9). Abnormal diastolic function is the most important component of the impaired cardiac function (10) while systolic dysfunction is not so common (11).

Several studies have reported a strong association between increased body mass index (BMI) and heart failure or left ventricular (LV) dysfunction (2). Excess body weight leads to increments in total blood volume and cardiac output and a decrease in total peripheral resistance. The volume overload induces chamber dilatation and leads to greater wall stress and myocardial hypertrophy (12). Echocardiography has consistently been the most accurate non-invasive method of assessing the left ventricular function (13). Recently, a 2D strain echocardiographic method has been introduced that measures myocardial deformation by tracking localized acoustic markers frame by frame (speckle tracking) (14,15). This method has been used for non-invasive assessment of regional myocardial strain in the left and the right ventricle, avoiding the angular sensitivity of tissue Doppler echocardiography (16).

The dramatic increase in the prevalence of obesity and its strong association with cardiovascular disease world over has resulted in unprecedented interest in understanding the effects of obesity on the cardiovascular system. Many studies have evaluated left ventricular (LV) systolic function in obesity but the findings of all these studies are quite variable. Present study was undertaken in obese young adult students to assess

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the hidden or potential patients in the society by assessing myocardial mechanics in them by way of ECG and Echocardiography.

MATERIAL & METHODS

The study was conducted in Postgraduate Department of Physiology and Cardiology Department Government Medical College Hospital, Jammu in 90 healthy both male & female non-diabetic, normotensive subjects without any other medical co morbidity in the age group of 18-25 years. They were selected randomly from medical college as well as surrounding degree colleges and university, belonging to different socioeconomic strata of the society and divided into Group I (Normal Weight), Group II (Overweight) & Group III (Obese). After taking permission from respective institutions, a list of subjects in the aforesaid age group was prepared. The eligible subjects were requested to participate in the study after explaining them purpose and methodology of the study. A written consent for ECG and Echocardiography was taken from the subjects beforehand. All the eligible subjects were reviewed and relevant information of the subjects like age, personal habits; present or past medical history, dietary habits as well as family history of obesity was recorded.

Participants were instructed to empty their bladder prior to anthropometric measurements (Height, Weight, BMI, Waist Circumference, Hip Circumference, Waist-Hip ratio) of participants was using a standard protocol. Similarly, Respiratory rate, pulse rate, blood pressure, both systolic and diastolic were also measured and recorded in each group separately.

A 12-lead electrocardiogram (ECG) was obtained and in the event of any pre-existing abnormality in the ECG, the candidate was excluded from the study group. A cross sectional echocardiogram was performed in all participants. Echocardiograms included cross sectional, M mode, 2D and Doppler studies was done by an experienced cardiologist using Siemens model ACUSON X 300. The indices of cardiac function evaluated were: (I) Left ventricular systolic function: Left ventricular end diastolic diameter (EDD), end systolic diameter (ESD) and fractional shortening (FS) was obtained in parasternal long axis views using M mode. The relative wall thickness (RWT) was calculated from the posterior wall thickness (PWT) and the EDD as (2 × PWT)/ EDD. (II) Left ventricular diastolic function: 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) and isovolumic relaxation time (IVRT). Sub-clinical dysfunction was assumed when two or more indices of altered diastolic or systolic functions were present.

Statistical Analysis

The data was analyzed using computer software Micro Excel and SPSS version 20.0 for Windows. Mean and Standard Deviation was calculated and reported for equivalent variables. The statistical difference in mean value were tested using unpaired student's 't' test. A p-value of <0.05 was considered a statistically significant. All p-values reported were two-tailed.

The following comparisons were done:

- Various Echocardiography findings in three groups.
- Age, Weight, Height, BMI, Hip Circumference, Waist Circumference, Waist/Hip ratio.
- Pulse Rate, Systolic and Diastolic Blood Pressure, Respiratory Rate.

RESULTS

The subjects were divided into 30 each in three group i.e Normal (Group I), Overweight (Group II) and Obese (Group III) and the observations made during the study are detailed herein:

Statistically the difference between the three groups for mean age was found to be insignificant, p> 0.05 (F=3.05, p=0.52), whereas, the difference in the mean weight of all three groups was observed to be statistically significant, p< 0.001 (F=33.82, P<0.001). Significance was observed in the comparison between three groups' i.e normal vs obese, normal vs overweight and obese vs overweight.

The mean height of subjects in Group I was 1.62 mtrs, in Group II was 1.61 mtrs whereas in Group III it was 1.53 mtrs. Statistically the difference in the mean height of all three groups was observed to be significant, p< 0.001 (F=5.729, p=0.005). Highly significant values were observed between Group I vs Group III as well as Group II vs Group III, whereas; in Group I vs Group II the values were insignificant. The mean BMI of subjects in Group I was 23.37 kg/mt^2, in Group II it was 27 kg/mt^2 whereas in Group III it was 36.26 kg/mt^2. Statistically the difference in the mean BMI of all three groups was observed to be significant, p< 0.001 (F=21.89, P<0.001). Highly significant values were observed between Group I vs Group III as well as Group II vs Group III, whereas in Group I vs Group II the values were insignificant.

The mean waist circumference of subjects in Group I was 109.40 cms, in Group II it was 96.91cms whereas in Group III it was 120.16 cms. Statistically the difference in the mean waist circumference of Group III vs Group II was significant and in Group I vs Group III as well as Group I vs Group II, it was not-significant (F=8.311, p=0.188, 0.094, <0.001)

The mean hip circumference of subjects in Group I was 105.03 cms, in Group II it was 109.15cms whereas in Group III it was 122.56 cms. Statistically the difference in the mean hip circumference of Group II vs Group III was not significant and in Group I vs Group III as well as Group I vs Group II, it was highly significant (F=13.707, p=0.003, <0.001, 0.286)

The mean waist/hip ratio of subjects in Group I was 0.74, in Group II it was 0.85 whereas in Group III t was 0.93. Statistically the difference in the mean waist/hip ratio in Group I vs Group III was highly significant (p<0.001), in Group I vs Group II it was significant (p=0.046) and in Group II vs Group III, it was not significant (F=9.863, p=0.160).

The mean respiratory rate of subjects in Group I was 13.56, in Group II it was 14.10 whereas in Group III it was 14.56. Statistically the difference in the mean respiratory rate in Group I vs Group III was highly significant (p=0.001), in Group I vs Group II and in Group II vs Group III, it was not significant (F=7.649, p=0.120, 0.215).

Table 1 Comparison of Demographic Parameters

	Mean Age	Mean Height	Mean Weight	Mean BMI	Mean Waist Circumference	Mean Hip Circumference	Mean Waist/Hip Ratio
Group I	21.93± 1.81	61.66±2.05	1.62±0.03	23.37±0.78	109.40±26.64	105.03±46.85	0.74±0.09
Group II	20.90± 1.60	69.53± 7.52	1.61± 0.84	27.00±1.27	96.91±17.23	109.15±15.74	0.85±0.18
Group III	21.03± 1.80	82.41± 15.20	1.53± 0.17	36.26± 13.39	120.16± 21.43	122.56± 20.21	0.93± 0.18

Table 2 Comparison of Clinical Parameters

	RR	PR	Mean SBP	Mean DBP
Group I	13.56±1.07	72.73±2.31	101.51±5.44	72.86±3.09
Group II	14.10±1.06	73.00±3.47	112.00± 5.14	74.73±4.74
Group III	14.56± 0.81	73.53± 3.13	111.80±4.46	73.63± 2.97

The mean pulse rate of subjects in Group I was 72.73 beats/mt, in Group II it was 73 beats/mt whereas in Group III it was 73.53 beats/mt. Statistically the difference in the mean pulse rate in normal vs obese was not significant in any of the inter-group comparisons (F=0.547, p=0.581).

The mean systolic BP of subjects in Group I was 101.51 mmHg, in Group II it was 112 mmHg whereas in Group III it was 111.80 mmHg. Statistically the difference in the mean systolic BP in Group I vs Group III and Group I vs Group I & Group II it was significant (p=0.027, 0.031), whereas in Group II vs Group III, it was not significant (F=4.65, p=1.000).

The mean diastolic BP of subjects in Group I (Normal) was 72.86 mmHg, in Group II (Overweight) it was 74.73 mmHg whereas in Group III (Obese) it was 73.63 mmHg. Statistically the difference in the mean diastolic BP was not significant in any of the inter-group comparisons (F=1.937, p=0.150).

Table 3 Comparisons of Systolic Dynamics

	EDD	ESD	FS	RWT	IVS-S
Group I	44.26±5.08	40.33±8.32	25.10±5.005	0.41± 0.11	8.36±1.09
Group II	44.26±5.08	28.00±4. 41	34.56±3.56	0.44± 0.12	9.16±1.94
Group III	44.80± 4.78	27.40± 4.53	34.00± 2.77	0.43± 0.09	13.80± 1.86

The mean EDD of subjects in Group I was 44.26 mm, in Group II it was 44.26 mm whereas in Group III it was 44.80 mm. Statistically the mean EDD was not significant in any of the inter-group comparisons (F=0.114, p=0.892).

The mean ESD of subjects in Group I was 40.33 mm, in Group II it was 28.00 mm whereas in Group III it was 27.40 mm. Statistically the difference in the mean ESD was highly significant in normal vs obese and normal vs overweight (F=43.850, p<0.001), whereas in obese vs overweight it was not significant (F=43.850, p=1.000).

The mean FS% of subjects in Group I was 25.10, in Group II it was 34.56 whereas in Group III it was 34.00. Statistically the difference in the mean FS% was highly significant in Group I vs Group III and Group I vs Group II (F=55.73, p<0.001), whereas in Group II vs Group III it was not significant (F=55.73, p=1.000).

The mean RWT of subjects in Group I was 0.41, in Group II it was 0.44 whereas in Group III it was 0.43 Statistically the difference in the mean RWT was not significant (F=0.513, p=0.601).The mean systolic IVS thickness of subjects in Group I was 8.36 mm, in Group II it was 9.16 mm whereas in Group III it was 13.80 mm. Statistically the difference in the mean systolic IVS thickness was highly significant in Group I vs Group III and Group II vs Group III (F=91.320, p<0.001), whereas in Group I vs Group II it was not significant (F=91.320, p=0.206).

Table 4 Comparison of Diasystolic Dynamics

	E-Wave	A-Wave	E/A Ratio	DT in sec	IVRT in msec
Group I	105.36 ±19.42	78.53 ±16.43	1.37±0.27	181.40 ±47.92	66.93±8.03
Group II	107.16±21.90	75.46±12.87	1.43±0.30	177.43±53.44	67.06±12.37
Group III	117.20± 29.29	85.96± 21.49	1.31± 0.21	196.06± 74.68	73.90±13.28

The mean E-wave of subjects in Group I was 105.36 cm/sec, in Group II it was 107.16 cm/sec whereas in Group III it was 117.20 cm/sec. Statistically the mean difference in E-wave value was not significant in any of the inter-group comparisons (F=2.133, p=0.125).

The mean A-wave of subjects in Group I was 78.53 cm/sec, in Group II it was 75.46 cm/sec whereas in Group III it was 85.96 cm/sec. Statistically the mean difference in A-wave value was not significant in any of the inter-group comparisons (F=2.922, p=0.059).

The mean E/A wave ratio of subjects in Group I was 1.37, in Group II it was 1.43 whereas in Group III it was 1.31. Statistically the mean difference in E/A wave ratio was not significant in any of the inter-group comparisons (F=1.532, p=0.222).

The mean DT of subjects in Group I was 181.40 msec, in Group II it was 177.43 msec whereas in Group III it was 196.06 msec. Statistically the difference in mean DT was not significant in any of the inter-group comparisons (F=0.808, p=0.449).

The mean IVRT of subjects in Group I was 66.93 msec, in Group II it was 67.06 msec whereas in Group III it was 73.90 msec. Statistically the difference in the mean IVRT was significant in Group I vs Group III (F=3.625, p=0.040), whereas in Group I vs Group II as well as Group II vs Group III the values were not significant (F=3.625, p=0.040, p=1, 0.070).

DISCUSSION

Overweight and obesity are the two most common nutritional disorders & has become a pandemic and is affecting almost all subsections of human population globally including developing countries like India, resulting into an increase in obesity related morbidity imposing heavy burden on healthcare system and lowering the quality of life of the obese people. In the present study an attempt has been made to assess the effect of overweight and obesity on the left ventricular myocardial mechanics in young adult students belonging to varied socioeconomic strata. Baseline parameters were recorded in all the three groups; Group I (Normal weight), Group II (Overweight) and Group III (Obese).

In the present study mean pulse rate of subjects, statistically the difference was not significant in any of the inter-group comparisons. Mean systolic BP of subjects was statistically significant in Group I (normal) vs Group III (obese) as well as Group I (normal) vs Group II (overweight) but in Group II (overweight) vs Group III (obese) , it was not significant. Mean diastolic BP in intergroup comparison was statistically not significant.

In the present study, mean body mass index (BMI) of subjects was statistically highly significant between normal vs obese as well as obese vs overweight but left ventricular function did not altered to the point of significance with increasing BMI. Peterson LR *et al* (7) reported that BMI values showed significant correlation with myocardial mechanics. Whereas, Krishna R *et al* (17) and Becker RJ *et al* (18) in their study found no correlation between BMI and LV wall thickness. Zangana SN *et al* (18) observed that no diastolic dysfunction was observed in normal weight subjects but diastolic dysfunction was seen in 12.9% (n=8) overweight subjects, 31.5% (n=15) of obese subjects and 47.5% (n=19) extremely obese subjects had diastolic dysfunction.

In present study, mean end diastolic diameter (EDD) of subjects statistically was not significant in any of the inter-group comparisons but marginal increase in EDD in three groups was in sharp contrast to Krishna R *et al* (17), who had reported increased LV end diastolic cavity dimensions in addition to LV mass/height and left arterial diameter in their series. Similarly Peterson LR *et al* (7) and Chadha DS *et al* (19) had also reported higher end diastolic septal and posterior wall thickness. Pandey AK *et al* (20) reported increased EDD in their series.

Mean end systolic diameter (ESD) was statistically highly significant in normal vs obese and normal vs overweight. This observation of present study was consistent with reports of other similarly situated studies (19, 20). This decrease in ESD points towards better contractile function of LV. It imply that in obese and overweight individuals of younger age group, there is a compensatory increase in systolic function which has not yet reached the stage of cardiac deteriorations.

In present study, statistically the difference in the mean FS % in inter group comparison was highly significant in normal vs obese and normal vs overweight FS% was much higher in obese and overweight subjects vis a vis normal subjects. This increase in FS points towards better systolic function in overweight and obese as compared with that of normal subjects. Pascul M *et al* (21) and Yaseen RI (22) reported similar finding, whereas; Obert P *et al* (23) reported no difference between obese and normal individuals for left ventricular shortening fraction.

Mean relative wall thickness (RWT), statistically the difference in the mean RWT was statistically not significant in inter group comparisons, indicating preserved systolic function. Pascul M *et al* (21) reported that left ventricular dimensions were increased ($p<0.001$) but RWT in obese was unchanged. Similarly, Zangana SN *et al* (18) and Obert P *et al* (23) reported that RWT was significantly higher in obese adolescent when compared to lean controls. Pandey AK *et al* (20) reported no significant difference in inter group comparison of RWT in their study.

In present study, mean passive velocity of mitral filling (E-wave) statistically was not significant in any of the inter-group comparisons. Similarly, mean active velocity of mitral filling (A-wave) of subjects in intergroup comparisons was statistically not significant. This observation of present study was consistent with the findings of other studies on the subject (18, 19, 20). Furthermore, mean E/A wave ratio of subjects in was also not significant in any of the inter-group comparisons. The findings were consistent with other available studies (18, 19,24), but were in contrast to findings of Pandey AK *et al* (20).

The E, A and E/A values did not differ across the spectrum of obesity. There is variable opinion in the literature as far as association of these indices with obesity is concerned. Otto ME *et al* (24) reported decrease in the E-wave as well as E/A ratio in their study, whereas; Di Bello V *et al* (25) and Van Putte-Katier N *et al* (26), found no significance difference in these indices in obesity. However in both studies E/A ratio was decreased in the former due to decrease in the E velocity and in the later study due to increase in maximum velocity of A-wave with unchanged velocity of E -wave.

Tumuklu MM *et al* (7), Pascual M *et al* (21) and Pirat B *et al* (27) in their studies observed that Doppler method is a good way of assessing diastolic function but when volume overload is present as seen in obesity, normal values may result because the increase in left atrial pressure caused by increased intravascular volume can mask the alterations observed in the early phases of abnormal diastolic relaxation.

In present study, statistically the difference in mean (deceleration time) DT was not significant in any of the inter-group comparisons. The parameters of DT in present study are in agreements with similarly situated studies in the literature (3, 18), whereas, Chadha DS *et al* (19) and Pandey AK *et al* (20) reported significant difference inter-group comparison of DT in their studies.

In present study, statistically the difference in the mean IVRT was significant in normal vs obese, whereas; in normal vs overweight as well as in overweight versus obese it was not significant. Peterson LR 2004 *et al* (3), reported that IVRT values were insignificant in their intergroup comparisons (Non-obese=88$\pm$11 msec, obese=92$\pm$13 msec, $p=0.26$). Our findings were in agreement with findings of Parveen KH *et al* (28) but were in contrast to findings of Zangana SN *et al* (18) as they reported no significant difference in IVRT values of intergroup comparisons. The only diastolic echocardiographic parameter that was altered to the point of significance was IVRT. There was progressive increase in IVRT with increasing BMI. IVRT was significantly increased in obese subjects (73.90 msec) as compared with that of normal subjects (66.93 msec). In the present study the subjects were younger and had shorter duration of obesity. This is consistent with findings of other studies (3, 7).

CONCLUSION

Obesity as chronic, progressive disease with increasing prevalence in both developed and developing countries; is associated with increased cardiovascular morbidity and mortality. As direct effect of isolated obesity on cardiac function has not been well established hence to determine the direct effect of overweight and obesity echocardiographic indices of systolic and diastolic function should be obtained and dysfunction needs to be assumed when at least two values differed by ≥2 SD from the normal weight group. From the present study we concluded that in young overweight and obese adult subjects systolic function was rather improved but none of these subjects were having diastolic dysfunction except IVRT on echocardiography. There were no significant ECG changes as far as cardiovascular physiological parameters are concerned. Our data was derived from young healthy adults and thus cannot be applied generally for all age groups even if individuals are healthy but study can definitely provides a foundation for future studies in pathological conditions. However, there is scope for further studies, like a prospective study can be undertaken in the same subjects after some more time to know any further change in cardiovascular physiological parameters in long standing obesity. Furthermore, a gender specific different age groups study in long standing obesity can also be undertaken for more clarity.

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