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ORIGINAL ARTICLE

Effect of Different Components of Metabolic Syndrome on Right Ventricular Volume and Function

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ABSTRACT

Background: Metabolic syndrome (Met. S.) is an association of multiple cardiovascular risk factors which consists of insulin resistance, diabetes or impaired glucose metabolism, central obesity, hypertriglyceridemia and low level of high-density lipoprotein cholesterol (HDL-C), in addition to hypertension.

Objective: The aim of the present work is to study the effect of different components of Met. S. on right ventricular volume and function.

Methods: This case control study had been conducted in cardiology department at Zagazig university hospitals. This study included 60participants, 30 cases and 30 controls.

Results: This case control study had been conducted in cardiology department at Zagazig university hospitals. Total number of subjects was 60 divided in to two groups: Group1- 30 patients with established components of Met. S.. Group2-30 controls. The Met. S. was defined by the presence of three or more criteria of the National Cholesterol Education Program's Adult Treatment Panel III (NCEPATP-III).

Conclusion: The effects of the components of metabolic syndrome on RV volume and function was evident in clinical and subclinical RV dysfunction. TAPSE and myocardial performance index Tei. index are good reliable methods for evaluation of RV function.

Keywords; Metabolic syndrome, right ventricular function, right ventricular volume

INTRODUCTION

Metabolic syndrome (Met. S.) is an association of multiple cardiovascular risk factors which consists of insulin resistance, diabetes or impaired glucose metabolism, central obesity, hypertriglyceridemia and low level of high-density lipoprotein cholesterol (HDL-C), in addition to hypertension **[1]**. The presence of Met. S. was found to be associated with an increased risk of cardiovascular mortality and major cardiovascular events in different clinical situations. This risk was attributed, at least in part, to the effect of Met. S. on left ventricular mass and functions **[2]**.The effect of different component on left ventricular mass and functions is a well-established matter. Many previous studies have proven the strong relationship between Met. S. and the development of left ventricular hypertrophy and impairment of its systolic and diastolic functions **[3,4,5]**.

However, there is some debate about the effect of different Met. S. components on right ventricular function. Metabolic syndrome was found to be associated with abnormal right ventricular and pulmonary artery hemodynamics. This abnormality was shown as shorter pulmonary artery acceleration time as well as a subclinical diastolic dysfunction of the right ventricle **[6]**. Also, the presence of either type 2 diabetes mellitus or hypertension was found to have a deleterious effect on right ventricular function and this effect was found to be stronger when the two conditions coexist**[7]**.On the other hand, other researchers have found no significant effect for either obesity and/or Met. S. on right ventricular function**[8]**.

The aim of this study was to evaluate the effect of different components of Met. S. on right ventricular volume and function.This case control study had been conducted in cardiology department at Zagazig university hospitals on 60 patients during the period from February 2018 to November 2018.All patients were divided in to two groups: Group1: included 30 patients with

established components of Met. S.

Group2 (controls group): included 30 healthy subjects. The Met. S. was defined by the presence of three or more criteria of the National Cholesterol Education Program's Adult Treatment Panel III (NCEPATP-III). Written informed consent was obtained from all participants and the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans. **Inclusion criteria:**

Patients with components of Met. S.

Exclusion criteria: Patient with pulmonary stenosis, Patients with structural heart disease affecting right ventricle such as dilatation and hypertrophy of the right ventricle, Patients with Previous valve replacement, Patients receiving chemotherapy, Patients with chronic renal failure, Patient with congenital heart disease ASD, VSD et.. and Patient with chronic pulmonary disease.

Study design: Case- control study

All studied Met. S. **patients had been subjected to: Data collection**

Data are collected for all patients at time of hospital admission, Or at time of echocardiography performance.**The data-collection sheet includes:** Demographic characteristics, such as (Age, Gender, body weight, height, waist circumference, and hip circumference).**Full history taking.**

Metabolic syndrome components,Laboratory investigation ,Echocardiography

RV Function: RV global function had been evaluated by Tricuspid annular plane systolic excursion (TAPSE), tricuspid annular systolic velocity (systolic velocity across lateral segment of tricuspid annulus;). The right ventricular myocardial performance index (TEI) which was defined as the ratio of total isovolumic time divided by ejection time ((IVRT + IVCT)/ET) using the pulsed tissue Doppler method. According to the ASE guidelines, aTAPSE < 16 mm, or RV TEI > 0.55 yielded high specificity for RV dysfunction. To achieve a robust presence of RV dysfunction and to minimize false positives ,RV dysfunction was assumed if one of these criteria was fulfilled plus at least one other borderline impairment. (TAPSE < 20mm or TEI > 0.45).

Statistical analysis

Data were collected, tabulated and analyzed by SPSS 20, software for Windows. P value was set at <0.05 for significant results, <0.001 for high significant result.

RESULTS

Table (1), showed that the age of the case group was (55.1±13.7) ranged from (18-70) years, (52%) of them were females, (48%) were smokers. Table (2), showed that the BMI in the case group was (35.4±5.3) ranged from (25.3 -44.9),Waist circumference in males was (118.1±7.7) ranged from (106 -134), Waist circumference in females was (127.5±22.5) ranged from (90 -160), Hip circumference was (118.4±11.9) ranged from (93 -139), (60.0%) were D.M, (73.3%) of the case group were hypertensive and (40.0%) had dyslipidemia. Table (3) showed that the WBCS, HB, platelets, creatinine, HBA1c, total cholesterol, triglycerides and HDL. Table (4) showed that the right ventricle diameters, area, RVED volume (mm), TAPSE (mm), and Tei index in the case group. Table (5) showed that the age of the control group was (52.3±10.6) ranged from (19-68) years, (50.0%) of them were females, (40.0%) were smokers. Table (6), showed that the BMI in the control group was (27.7±2.9) ranged from (23.6 -32.4), Waist circumference in males was (94.6±8.9) ranged from (87 -118), Waist circumference in females was (99.2±9.6) ranged from (87 -118), Hip circumference was (100.1±8.7) ranged from (85 -113), with no D.M, HTN nor dyslipidemia. Table (7), showed that there was no statistically significant difference between the case and control groups in age sex and smoking.

Table (1): Demographic characteristics of the case group:

Variable	**The case group (30) mean ± SD (Range) median**	
Age ***(Years)***	55.1±13.7 (18-70) 58	
Variable	**NO (30)**	**%**
Sex ***Male*** ***Female***	14 16	48.0 % 52.0 %
Smoking	12	40.0%

Variable	The case group (30) mean ± SD (Range) median	
Yes	18	60.0%
No		

Table (2): Clinical data of the case group:

Variable	The case group (30) mean ± SD (Range) Median	
BMI	35.4±5.3 (25.3 -44.9) 33.9	
Waist circumference males (cm)	118.1±7.7 (106 -134) 119	
Waist circumference females (cm)	127.5±22.5 (90 -160) 123	
Hip circumference (cm)	118.4±11.9 (93 -139) 118	
Variable	**NO (30)**	**%**
D.M ***Yes*** ***No***	 18 12	 60.0% 40.0%
HTN ***Yes*** ***No***	 22 8	 73.3% 26.7%
Dyslipidemia ***Yes*** ***No***	 12 18	 40.0% 60.0%

Table (3): Laboratory data of the case group:

Variable	The case group (30) mean ± SD (Range) Median
WBCs×1000	10.6±5.5 (4.5 -26.8) 9
HB	12.9±1.6 (10.5 -16) 12.7
PLT×1000	241±62.1 (135 -340) 250
Creatinine (mg/dl)	1.06±0.1 (0.9 -1.3) 1.04
HBA1c	7.6±2.2 (4.3 -10) 8.7
Total Cholesterol (mg/dl)	212.7±39.9 (160 -285) 193

Variable	The case group (30) mean ± SD (Range) Median
TAG	158.1±23.1 (135 -200) 145
HDL (mg/dl)	48.9±9.9 (30 -62) 53

Table (4): ECHO finding data of the case group:

Variable	The case group(30) mean ± SD (Range) Median
Right ventricle M	2.8±0.3 (2.1-3.6) 2.9
Right ventricle B	3.9±0.3 (3.6 -4.6) 4
Right ventricle L	6.3±0.9 (4.2 -8.4) 6.2
RVArea(cm2)	19.2±2.4 (15.6 -23.6) 18.7
RVED volume(ml)	95.5±20.5 (53 -129) 88
TAPSE(mm)	2.2±0.3 (2 -3.4) 2.1
Tei index	0.4±0.1 (0.18 -0.73) 0.45

M = Mid, B = basal, L = Longitudinal

Table (5): Demographic characteristics of the control group:

Variable	The control group(30) mean ± SD (Range) Median	
Age ***(Years)***	52.3±10.6 (19-68) 55	
Variable	**NO(30)**	**%**
Sex ***Male*** ***Female***	 15 15	 50.0% 50.0%
Smoking ***Yes*** ***No***	 12 18	 40.0% 60.0%

Table (6): Clinical data of the control group:

Variable	**The control group(30)** **mean ± SD** **(Range)** **Median**	
BMI	27.7±2.9 (23.6 -32.4) 27.3	
Waist circumference males (cm)	94.6±8.9 (87 -118) 90	
Waist circumference females (cm)	99.2±9.6 (87 -118) 97.5	
Hip circumference (cm)	100.1±8.7 (85 -113) 100.5	
Variable	**NO(30)**	**%**
D.M ***Yes*** ***No***	 0.0 30	 00.0% 100.0%
HTN ***Yes*** ***No***	 0.0 30	 00.0% 100.0%
Dyslipidemia ***Yes*** ***No***	 0.0 30	 00.0% 100.0%

Table (7): Comparing socio-demographic characteristics between case and control groups

Variable	**Case (30)** **mean ± SD** **(Range)** **median**	**Control (30)** **mean ± SD** **(Range)** **median**	**Test**	**p-value**
Age (years)	55.1±13.7 (18-70) 58	52.3±10.6 (19-68) 55	1.6	0.7
Variable	**Case** **No(30) %**	**Control** **No(30) %**	**χ^2**	**p-value**
Sex ***Male*** ***Female***	 14 46.7% 16 52.3%	 15 50.0% 15 50.0%	 0.06	 0.7
Smoking ***yes*** ***no***	 12 40.0% 18 60.0%	 12 40.0% 18 60.0%	 0.0	 1

Table (7**)** showed that there was no statistically significant difference between the case and control groups in age sex and smoking.

Table (8): Correlation between RVED volume, TAPSE, Tei-index and other ECHO findings in the control group:

Variable	***RVED volumer*** **p SIG**	***TAPSE*** **r p SIG**	***Tei-index*** **r p SIG**
Right ventricle M	0.1 >0.05 NS	0.1 >0.05 NS	0.1 >0.05 NS

Variable	*RVED volumer* p SIG	*TAPSE* r p SIG	*Tei-index* r p SIG
Right ventricle B	**0.3 0.02* S**	0.2 >0.05 NS	0.3 >0.05 NS
Right ventricle L	**0.9 0.001** HS**	0.1 >0.05 NS	**0.6 0.001** HS**
Area	**0.8 0.001** HS**	**0.3 0.003* S**	0.2 >0.05 NS
RVED volume	----------	**0.8 0.001** HS**	**0.5 0.005* S**
TAPSE	**0.5 0.001** HS**	----------	**-0.4 0.001** HS**
Tei index	**0.8 0.001** HS**	0.1 >0.05 NS	----------

M = Mid, B = basal, L = Longitudinal

r=correlation, p=p-value, S=Significance, HS=High significance, NS=Not significant.

* Statistically significant difference ($P \leq 0.05$)

** Statistically highly significant difference ($P \leq 0.001$)

DISCUSSION

Obesity and the metabolic syndrome are fast-growing disorders in western countries which are associated with variant cardiovascular abnormalities leading to a high risk of cardiovascular morbidity and mortality**[9]**.

The Framingham Heart Study demonstrated a 2-fold higher risk of developing heart failure in obese subjects with a body mass index ≥ 30 kg/m2 in comparison to non-obese ones in a large community-based sample**[10]**.Moreover, adiposity was described as an independent risk factor for developing heart failure with a population attributable risk of 8.0% in large prospective cohort study with a follow- up of 19 years **[11]**.Arterial hypertension, impaired glucose tolerance, dyslipidemia, altered hemodynamics, elevation of neurohumoral and inflammatory markers, prothrombotic state, and obstructive sleep apnea are associated conditions which may further predispose to heart failure**[10]**.While the influence of obesity on left ventricular (LV) function is understood in more detail, such as the correlation of body mass index (BMI) with increased LV mass, LV wall thickness, and an impaired systolic and diastolic LV function, there is only limited evidence on right ventricular (RV) function **[12,13]**.The impact of metabolic syndrome (Met. S.) on the right ventricle (RV) is not well clarified. Additional mechanisms that are common for all Met. S. criteria and the MetS itself and that could explain the relationship between the Met. S. and right heart dysfunction are: insulin resistance, endothelial dysfunction, and increased activity of the rennin -angiotensin- aldosterone system**[14]**.

In this study, the effect of Met. S. on RV systolic and diastolic performance was investigated as well as the RV volume ,60 individuals where enrolled in this study divided into two groups: Group (1) included **30** patients with components of metabolic syndrome and matching inclusion exclusion criteria. Group (2) included **30** healthy subjects. Both groups of our study show nearly same distribution of age group, and sex. On the other hand there is statistically significant difference between case and control groups regarding the components of metabolic syndrome with higher BMI values in case group over the control group.

The present study shows slightly increase in both basal and mid right ventricular diameter in case group over the control group with statistically highly significant difference ($P \leq 0.001$) and this is in agreement with study of **Gopal et al [6]** which found that Met. S. was associated with subclinical alterations in RV diastolic function and heamodynamics**.** One of main finding of our study is the RVED volume which is significantly larger in Met. S. group over the control group, and this finding is in agreement with the study of **Tadic. et al. [15]** as he conduct cross-sectional study included 108 untreated subjects with the Met. S. and 75 control subjects similar according to sex and age the Met. S. was defined by the presence - 3 American Heart Association/National Heart, Lung, and Blood Institute criteria, as in our study. All the subjects underwent adequate laboratory analyses and complete 2D echo. and 3D echo. examination. Using 3D echo. Examination he found that patients with Met. S. had larger RVED volumes over the control group.Met. S. patients showed to have impairment of systolic right

ventricular function as they have lower TAPSE reading in comparable to controls and this finding is concordant with the study of **Gaber et al [16]** and **Zeller et al. [8]** who found that patients with RV dysfunction presented with a higher BMI and more pronounced metabolic syndrome parameters. One of the main findings of this study is that, although it remained within normal limits, TAPSE was significantly lower in Met. S. patients compared to controls. The first study on RV functions in MetS patients was reported by Tadic et al., in which MetS was found to be related to RV dysfunction, caused by RV hypertrophy, increased right atrial volume and RV Tei index. In our study, RV Tei index was significantly increased in MetS patients compared to normal subjects. The significant increase of the RV Tei index in the MtS group indicated the damage of the global systolic and diastolic RV function which in agreement with the study of **Tadic et al.[15].**In our study we found that the diabetic patients with Met. S. show to have shorter right ventricular end diastolic med diameter than non-diabetic patients with Met. S., also the diabetic patients have statistically significant higher RVED volumes and slightly higher Tei index which indicate more pronounced RV dysfunction, and this finding is going with the study of **Parsaee et al. [17]**. Who studied twenty-two diabetic patients without any coronary artery disease, hypertension, or left ventricular dysfunction. The right ventricular end diastolic diameter, tricuspid plane systolic excursion, right ventricular inflow Doppler parameters, and compared to 22 healthy individuals, and he found that diabetes mellitus type II can influence the right ventricular function in the absence of coronary artery disease, LV systolic dysfunction, and pulmonary hypertension.

On the other hand **Eweda [7]**, studied the effect of DM alone and superadded by HTN on right ventricular function and she found unlike the other studies, DM alone did not show effects on the RV function, but the combined effect of both ,DM and HTN on RV function is more evident in all parameters. Also in comparison between hypertensive patients with MetS and normotensive patients with MetS there is statistically significant difference regarding the med and basal RVED diameters which they are increased in hypertensive MetS patients as well as higher RVED volumes and this finding is in agreement with study of **Gopal et al. [6] and study of Tadic et al. [15]**.

CONCLUSION

The effects of the components of metabolic syndrome on RV volume and function was evident in clinical and subclinical RV dysfunction. TAPSE and myocardial performance index Tei. index are good reliable methods for evaluation of RV function. TAPSE and myocardial performance index Tei. index are good reliable methods for evaluation of RV function.

REFERENCES

1. **Reaven GM.** Role of insulin resistance in human disease: Banting Lecture.. Diabetes 1988; 37 : 1595-1607.
2. **Schillaci G, Pirro M, Vaudo G.** Prognostic value of the metabolic syndrome in essential hypertension. J Am CollCardiol 2004; 43 (10): 1817-1822.
3. **Schillaci G, Pirro M, Pucci G, Mannarino M, Gemelli F, Siepi D.** Different impact of the metabolic syndrome on left ventricular structure and function in hypertensive men and women. Hypertension 2006; 47 (5): 881-886.
4. **Rutter MK, Meigs JB, Sullivan LM, D'Agostino Sr R, Wilson P.** C-reactive protein, the metabolic syndrome, and prediction of cardiovascular events in the Framingham Offspring Study. Circulation 2004; 110: 380–85.
5. **Al-Daydamony MM, El-Tahlawi M.** What Is the Effect of Metabolic Syndrome without Hypertension on Left Ventricular Hypertrophy? Echocardiography. 2016; 33 (9): 1284-1289
6. **Gopal DM, Santhanakrishnan R, Wang YC, Ayalon N., Donohue C., Rahban Y.** Impaired right ventricular hemodynamics indicate preclinical pulmonary hypertension in patients with metabolic syndrome. Journal of the American Heart Association 2015, 4(3): e001597
7. **Eweda II.** Hypertension and Diabetes Mellitus: How Do They Affect the Right Ventricular Functions Individually and Together? J CardiovascEchogr 2017; 27(3): 88-92
8. **Zeller J, Strack C, Fenk S, Mohr M, Loew T, Schmitz G.** Relation Between Obesity, Metabolic Syndrome, Successful Long-Term Weight Reduction, and Right Ventricular Function. Int Heart J 2016; 57(4): 441-448.
9. **Poirier P, Giles TD, Bray GA, Hong Y, Stern JS, Pi-Sunyer FX, Eckel RH.** Obesity and cardiovascular disease: pathophysiology, evaluation, and effect of weight loss: an update of the 1997 American Heart Association Scientific Statement on Obesity and Heart Disease from the Obesity Committee of the Council on Nutrition, Physical Activity, and Metabolism. Circulation 2006; 113: 898-918. (Review).
10. **Kenchaiah S, Evans JC, Levy D, Wilson PW, Benjamin EJ, Larson MG.** Obesity and the risk of heart failure. New England Journal of Medicine 2002; 347 (5): 305-313.
11. **He J, Ogden LG, Bazzano LA, Vupputuri S, Loria C, Whelton PK.** Risk factors for congestive heart failure in US men and women: NHANES I

epidemiologic follow-up study. Arch Intern Med 2001; 161: 996-1002

12. **Alpert MA.** Obesity cardiomyopathy: pathophysiology and evolution of the clinical syndrome. Am J Med Sci 2001; 321: 225-36. (Review).
13. **Cuspidi C, Rescaldani M, Sala C, Grassi G.** Left-ventricular hypertrophy and obesity: a systematic review and meta-analysis of echocardiographic studies. J Hypertens 2014; 32: 16-25. (Review)
14. **Fitchett D, Connelly KA.** Impaired cardiac function in metabolic syndrome. Canadian Journal of Cardiology 2014, 30(3), 270-271.
15. **Tadic M, Cuspidi C, Majstorovic A, Pencic B, Backovic S, Ivanovic B.** Does the metabolic syndrome impact left-ventricular mechanics? two-dimensional speckle tracking study. Journal of hypertension. 2014 Sep 1;32(9):1870-8.
16. **Gaber R, Kotb NA.** Early diagnosis of right ventricular dysfunction in type II diabetes mellitus: value of 3 dimensional strain/strain rate. Heart mirror J 2010;4:80-85.

Parsaee M, Bahmanziari P, Ardeshiri M, Esmaeilzadeh M. Obvious or Subclinical Right Ventricular Dysfunction in Diabetes Mellitus (Type II): An Echocardiographic Tissue Deformation Study. J Teh Univ Heart Ctr 2012;7(4):177-181

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