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Evaluation of Left Ventricular Diastolic Function in Patients with Metabolic Syndrome

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Abstract: Metabolic Syndrome (MetS) is a group of clinical disorders, is widespread and correlated with elevated cardiovascular morbidity and mortality. Total 300 subjects with metabolic syndrome according to the Harmonized criteria underwent 2D echo and Doppler imaging in the present prospective, observational cohort study. Present study demonstrated the high prevalence of diastolic dysfunction with metabolic syndrome in asymptomatic subjects. About three-fourth of the subjects with metabolic syndrome had diastolic dysfunction. A historical factor in the worsening of diastolic function is the increasing age, high prevalence of diastolic dysfunction in middle-aged patients with metabolic syndrome, highlighting the need for timely recognition and early intervention before the development of diastolic heart failure in these patients.

INTRODUCTION

Metabolic Syndrome (MetS) is a group of clinical disorders is widespread and correlated with elevated cardiovascular morbidity and mortality. MetS is the category of risk factors that involve elevated blood pressure, hyperglycemia and abdominal obesity. An improvement in the configuration and operation of the left ventricle is one of the implications of the detrimental symptoms of metabolic syndrome. Metabolic syndrome is a group of cardiovascular risk factors that are responsible for the production of target organ injury (Alberti *et al*., 2005).

The incidence of metabolic syndrome in developed nations is about 22% of the young population and >40% of those above 50 years of age (Ford *et al*., 2002). It is also well established that the incidence of MetS depends on gender and ethnicity. Already, surveys indicate equal occurrence in emerging countries like India as in industrialized countries.

Aim and objectives

Aim: Evaluation of left ventricular diastolic activity in pre-clinical patients with metabolic syndrome.

Objectives: Correlate left ventricular diastolic function in relation to severity of dyslipidemia. Correlate left ventricular diastolic function in relation to severity of obesity. Correlate left ventricular diastolic function in relation to severity of hypertension.

Literature review: The medical criteria for the diagnosis of metabolic syndrome as described in the Adult Treatment Panel III (ATP III) National Cholesterol Education Program study are 102 cm (40 in) and 88 cm (over 35) in males. Waist circumference is also included. In women; triglyceride levels of at least 150 mg dL^{-1} (1.70 mmol L^{-1}); lipoprotein cholesterol levels with high density are greater than 40 mg dL^{-1} (1.04 mmol L^{-1}) in men and 50 mg dL^{-1} (1.30 mmol L^{-1}) in women; blood pressure of at least 130/85 mm hg and glucose levels of at least 110 mg dL^{-1} (6.10 mmol L^{-1}).

The mechanisms underlying metabolic syndrome are not fully known (Eckel *et al*., 2005). The role of the sedentary lifestyle patterns is well known in the development of metabolic syndrome (Reaven, 1988). Metabolic syndrome is a complex syndrome that is influenced by and interacts with, genetic and environmental factors. While the metabolic syndrome is believed to involve multi-functional involvement, insulin tolerance and abdominal obesity are the most widely established and combined theory to explain the pathophysiological cause of metabolic syndrome (Reaven, 1988; Eckel *et al*., 2005; Wassink *et al*., 2007; Laaksonen *et al*., 2008). Also, as part of the Hypertension pathogenesis. There is only partial understanding of the metabolic syndrome (Kyhl *et al*., 2015).

The two physiological stages of diastole, active relaxing and passive loading, are also affected by myocardial ischemia and infarction. Effective recovery is slowed after a myocardial infarction whereas left ventricular tension varies based on the degree of infarction and remodeling. Increased wall stiffness causes interstitial edema and fibrosis which is counteracted by chamber dilation. Patients with comorbid conditions associated with worse diastolic function have been found to tend to have more adverse effects after myocardial infarction (Gates *et al*., 2003).

MATERIALS AND METHODS

The current study was conducted during the period of October, 2014 to March, 2016 in a tertiary care, OPD of teaching hospital and general medical department in patients attending IPD.

Type of study: This was 18 month prospective, non-interventional cohort study done in patients with metabolic syndrome.

Study setting: Patients consulting in Medicine OPD and admitted in wards of tertiary care hospital who satisfy the inclusion criteria were enrolled in the study.

Sample size:

$$\text{Sample size} = \frac{Z^2 * (p) * (1\text{-}p)}{c^2}$$

$$\text{Sample size} = \frac{1.96^2 * 0.68 * 0.32}{0.05^2} = 334$$

Where:

Z = Z value (e.g., 1.96 for 95% confidence level)
p = Expected prevalence from a previous/pilot study
c = Absolute error (based on confidence level), ..., 0.05 if z value is 1.96

All the patients diagnosed as cases of metabolic syndrome according to harmonized criteria for metabolic syndrome (Alberti *et al*., 2009) coming to OPD and admitted in IPD with a minimum of 300 patients within the 18 month time period of 1 October, 2014 to 31 March, 2016.

Method and collection of data

Data collection: Total 300 patients consulting in OPD and admitted in wards of a tertiary care, teaching hospital were listed in the study satisfying inclusion and exclusion criteria. A detailed history obtained from the subjects with special emphasis on age, occupation, dietary habits, physical activity and habits like alcoholism, tobacco consumption and smoking. History of intake of drugs affecting lipid levels, anti-hypertensives, oral hypoglycemic agents, drugs affecting cardiac remodeling like beta-blockers, angiotensin converting enzyme inhibitors, aldosterone antagonists and antiplatelets was obtained.

Methods: Data were elicited from the patients and recorded in proforma.

Socio demographic data: Age, occupation, gender, clinical history questionnaire, physical activity questionnaire, history and duration of diabetes and hypertension, family history of diabetes and hypertension, history of smoking, alcohol consumption, tobacco consumption, selected data were elicited from the patients and recorded in proforma. Weight was measured in kilograms using electronic digital scale. The digital LED confirmed to be at 000.00 before weighing the patient. Height was measured by stadiometer and recorded in centimeters. Measurements were done as per cardiovascular survey methods. Body Mass Index (BMI) was calculated as: weight in kg m^{-1} height (Shimizu *et al*., 1985).

All the subjects with metabolic syndrome were asked to come two hours after their last meal and asked to change to hospital gown and requested to rest for 30 min prior to the procedure. The subject was placed in left lateral position and resting transthoracic 2-dimensional echocardiography (TTE) and Doppler imaging was done using Acuson-Seimens-X300 echocardiography machine. Pulse-wave Doppler was done to calculate trans-mitral inflow velocities in apical 4 chamber view. Tissue Doppler Imaging (TDI) was done to measure velocity of mitral annular motion and measurement of early diastolic filling was done. Metabolic syndrome was defined according to harmonized criteria by a joint interim statement of the IDF Task Force on Epidemiology and Prevention, NHLBI and AHA Guidelines (Kyhl *et al*., 2015).

Patient information obtained was kept confidential and only competent authorities like the Institutional ethics committee, institutional review board were allowed to access the data. Medical records treated as confidential and only that data which does not identify the patient is shared with the above and is to be published.

Statistical analysis: Results of demographic, clinical and biochemical characteristics were expressed as range, mean and median. The Statistical Software SPSS-23 trial version was used for analysis of the data; Microsoft word and Excel Version 2010 were used to generate graphs and tables. For evaluate qualitative data, the Pearson Chi-square method was introduced and the $p<0.05$ was considered important.

RESULTS AND DISCUSSION

The present prospective, observational cohort study was performed in a tertiary care hospital in a duration of 18 months from 1st October, 2014 to 31st March, 2016. A total of 300 subjects fulfilling the inclusion criteria for metabolic syndrome by the Harmonized definition were enrolled in the study, out of which 156 (52%) were male and 144 (48%) were female. A recent study has found the prevalence of diastolic dysfunction in community to be as high as 27.3%.[9] In our study, the incidence of diastolic dysfunction (DD) in MetS subjects was 72% (216 out of 300 subjects had diastolic dysfunction in the present study).

The mean age of the subjects included in the study was 36.5 (±6.6) years (in subjects with normal diastolic function it was 35.1 (±6.95) years and in subjects with diastolic dysfunction it was 37.0 (±6.41) years). Increasing age was associated with worsening of diastolic function with 69.8% of the subjects in the age group of 25-30 years having diastolic dysfunction while it was present in 90.6% of the subjects in age group of 46-50 years. Our study showed a significant correlation of diastolic dysfunction with increasing age (-$p<0.001$). Mean age of subjects with grade I DD was 37.03 (±6.41) years, grade II DD was 36.30 (±6.04) years and grade III DD was 37.92 (±6.72) years, suggesting worsening of diastolic function with increasing age. The strong heart study did not find a convincing correlation of gender with diastolic function after matching for age and other confounding variables while a study by Fischer *et al*. (2003) found a male predominance (Table 1-4).

Russo *et al*. (2011) on affect of obesity and overweight on diastolic left ventricular activity. In a study by Antoine Kossaify in 2013 on impact of obesity on LV Diastolic Function including 99 patients there was an independent and direct effect of BMI on diastolic function with overweight and obesity having an independent negative impact on diastolic function as assessed by Tissue Doppler Imaging (Lakka *et al*., 2003). Similar association of BMI with left ventricular diastolic dysfunction was seen in studies by Paul *et al*. (2015) and Ayalon *et al*. (2014).

Table 1: Distribution of participants according to age

Age group (Years)	Frequency n = 300	Percentage
25-30	63	21
31-35	72	24
36-40	77	25
41-45	56	18.67
46-50	32	10.66
n = 300	300	100

Mean age = 36.5 (±6.6) years; Men = 36.3 (±6.0) years; Women = 36.7 (±7.3) years

Table 2: Gender wise distribution of participants according to triglyceride levels

	TG levels (mg dL^{-1})				
Gender	<150 (Optimal)	150-199 (Borderline high)	200-499 (High)	Very high (≥500)	n = 300
Male	50 (16.66%)	66 (22.0%)	33 (11.0%)	7 (2.33%)	156
Female	59 (19.66%)	51 (17.0%)	23 (7.66%)	11 (3.66%)	144
n=300	109 (36.33%)	117 (39.0%)	56 (18.33%)	18 (6.0%)	300 (100%)

Mean Triglyceride levels = 93.8 mg dL^{-1}; Men = 190.3 mg dL^{-1}; Women = 197.5 mg dL^{-1}

Table 3: Gender wise distribution of participants according to waist circumference

Waist circumference	Frequency in male	Frequency in female	n = 300
Normal	46 (15.33%)	26 (8.66%)	72 (24.0%)
Obese	110 (36.66%)	118 (39.33%)	228 (76.0%)
n = 300	156	144	300

Mean waist circumference = 90.34 (±9.65) cm; Men = 92.28 (±8.69) cm; Women = 88.23 (±10.21) cm

Table 4: Gender wise distribution of participants according to blood pressure

Blood pressure	Frequency in male	Frequency in female	n = 300
<120/80 mmHg (Normal)	32 (10.66%)	37 (12.33%)	69 (23%)
120-129 mmHg SBP and DBP <80 mmHg (Elevated)	45 (15%)	24 (8%)	69(23%)
130-139mmHg SBP or DBP 80-89 mmHg(HTN Stage 1)	35 (11.66%)	23 (7.66%)	58 (19.33%)
≥140/90 mmHg (HTN Stage 2)	44 (14.66%)	60 (20%)	104 (34.66%)
n = 300	156	144	300

Mean SBP = 130.97 (±12.12) mmHg; Men = 130.37 (±11.42) mmHg; Women = 131.62 (±12.85) mmHg; Mean DBP- 82.73 (±6.82) mmHg; Men = 82.09 (±6.77) mmHg; Women = 83.41 (±6.84) mmHg

Khan and Khan (2008) and Tadic *et al*. (2012) where a statistically significant correlation was found between waist circumference and worsening diastolic function.

CONCLUSION

The present study highlighted the high incidence of diastolic dysfunction with metabolic syndrome in asymptomatic subjects. About three-quarters of the subjects with metabolic syndrome had diastolic dysfunction. Around half of the diastolic disorder subjects had Grade I diastolic disorder. In the present study, left ventricular diastolic function was associated with the individual components of metabolic syndrome, age and sex. Diastolic dysfunction was found to be significantly higher in metabolic syndrome with an increase in age and female gender. There was a significant correlation of fasting blood sugar, glycosylated hemoglobin (HbA1c), waist circumference and diastolic dysfunction with BMI, hypertriglyceridemia and hypertension. There was no significant correlation of HDL-cholesterol levels and diastolic dysfunction from waist to hip ratio. The prevalence of diastolic dysfunction was significant with five components compared to three components and four components of metabolic syndrome. A historical factor in worsening of diastolic function is the increasing age, high prevalence of diastolic dysfunction in middle-aged patients with metabolic syndrome, highlighting the need for timely recognition and early intervention before the development of diastolic heart failure in these patients.

REFERENCES

Alberti, K.G., R.H. Eckel S.M. Grundy, P.Z. Zimmet and J.I. Cleeman *et al*., 2009. Harmonizing the metabolic syndrome: A joint interim statement of the international diabetes federation task force on epidemiology and prevention; National heart, lung and blood institute; American heart association; world heart federation; international Atherosclerosis society and international association for the study of obesity. Circulation, 120: 1640-1645.

Alberti, K.G.M., P. Zimmet and J. Shaw, 2005. The metabolic syndrome-a new worldwide definition. Lancet, 366: 1059-1062.

Ayalon, N., D.M. Gopal, D.M. Mooney, J.S. Simonetti and J.R. Grossman *et al*., 2014. Preclinical left ventricular diastolic dysfunction in metabolic syndrome. Am. J. Cardiol., 114: 838-842.

Eckel, R.H., S.M. Grundy and P.Z. Zimmet, 2005. The metabolic syndrome. Lancet, 365: 1415-1428.

Fischer, M., A. Baessler, H.W. Hense, C. Hengstenberg and M. Muscholl *et al*., 2003. Prevalence of left ventricular diastolic dysfunction in the community: Results from a Doppler echocardiographic-based survey of a population sample. Eur. Heart J., 24: 320-328.

Ford, E.S., W.H. Giles and W.H. Dietz, 2002. Prevalence of the metabolic syndrome among US adults: Findings from the Third national health and nutrition examination survey. J. Am. Med. Assoc., 287: 356-359.

Gates, P.E., H. Tanaka, J. Graves and D.R. Seals, 2003. Left ventricular structure and diastolic function with human ageing: Relation to habitual exercise and arterial stiffness. Eur. Heart J., 24: 2213-2220.

Khan, A.R. and M.Q. Khan, 2008. Association and pattern of diastolic dysfunction in patients of metabolic syndrome. J. Ayub Med. Coll. Abbottabad, 20: 70-75.

Kyhl, K., N. Vejlstrup, J. Lonborg, M. Treiman and K.A. Ahtarovski *et al*., 2015. Predictors and prognostic value of left atrial remodelling after acute myocardial infarction. Open Heart, Vol. 2, 10.1136/openhrt-2014-000223

Laaksonen, D.E., L. Niskanen, K. Nyyssonen, T.A. Lakka, J.A. Laukkanen and J.T. Salonen, 2008. Dyslipidaemia as a predictor of hypertension in middle-aged men. Eur. Heart J., 29: 2561-2568.

Lakka, T.A., D.E. Laaksonen, H.M. Lakka, N. Mannikko, L.K. Niskanen, R. Rauramma and J.T. Salonen, 2003. Sedentary lifestyle, poor cardiorespiratory fitness and the metabolic syndrome. Med. Sci. Sports Exercise, 35: 1279-1286.

Paul, R., P.K. Sinha, S. Mookherjee, P. Raychaudhuri, A. Maiti, S. Mukherjee and S.K. Dey, 2015. Prevalence of left ventricular diastolic dysfunction in patients with normal systolic function and its relation with other risk factors from Eastern India. Indian Med. Gaz., 1: 54-61.

Reaven, G.M., 1988. Role of insulin resistance in human disease. Diabetes, 37: 1595-1607.

Russo, C., Z. Jin, S. Homma, T. Rundek, M.S. Elkind, R.L. Sacco and M.R. Di Tullio, 2011. Effect of obesity and overweight on left ventricular diastolic function: A community-based study in an elderly cohort. J. Am. Coll. Cardiol., 57: 1368-1374.

Shimizu, G., M.R. Zile, A.S. Blaustein and W.H. Gaasch, 1985. Left ventricular chamber filling and midwall fiber lengthening in patients with left ventricular hypertrophy: Overestimation of fiber velocities by conventional midwall measurements. Circulation, 71: 266-272.

Tadic, M., B. Ivanovic, N. Kostic, D. Simic, D. Matic and V. Celic, 2012. Metabolic syndrome and left ventricular function: Is the number of criteria actually important?. Med. Sci. Monit. Int. Med. J. Exp. Clin. Res., 18: CR282-CR289.

Wassink, A.M.J., J.K. Olijhoek and F.L.J. Visseren, 2007. The metabolic syndrome: Metabolic changes with vascular consequences. Eur. J. Clin. Invest., 37: 8-17.