Impact of metabolic syndrome on global left ventricular function: As evaluated by the myocardial performance index

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Background: **Metabolic syndrome is associated with the development of diabetes mellitus and cardiovascular disease. The impact of metabolic syndrome on the progression of atherosclerosis has been well documented. This study was designed to evaluate the impact of metabolic syndrome on global left ventricular function by using left ventricular myocardial performance index (LVMPI).**

Methods: **The diagnosis of metabolic syndrome was made as per the criteria of the International Diabetes Federation. Echocardiography was performed with a Philips IE33 machine using a 1–5 MHz transthoracic probe. LVMPI was calculated by adding isovolumic contraction time with isovolumic relaxation time and dividing it by ejection time.**

Results: **The mean LVMPI value in metabolic syndrome was 0.64 ± 0.09, while that in controls was 0.48 ± 0.06 ($p < 0.001$). Metabolic syndrome was seen to have more significant influence on LVMPI.**

Conclusions: **Metabolic syndrome is a strong predictor of sub-clinical myocardial dysfunction in subjects free of clinically apparent heart disease.**

Keywords: Metabolic syndrome, Myocardial performance index, Isovolumic relaxation time, Isovolumic contraction time

Introduction

Metabolic syndrome (MetS) constitutes a constellation of metabolic abnormalities that confer an increased risk of cardiovascular disease and diabetes mellitus (DM). Although the impact of MetS on the progression of atherosclerosis has been well documented, its effects on left ventricular function have not been extensively evaluated [1–3]. Metabolic syndrome is considered to be an independent risk factor for heart failure.

At least one third of patients with heart failure have both systolic and diastolic dysfunction. A

Disclosure: Authors have nothing to disclose with regard to commercial support.
Received 6 December 2013; revised 17 March 2014; accepted 26 March 2014.
Available online 3 April 2014

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Peer review under responsibility of King Saud University.
URL: www.ksu.edu.sa
http://dx.doi.org/10.1016/j.jsha.2014.03.003

Production and hosting by Elsevier

Doppler-derived index of myocardial performance (Tei index), combining both systolic and diastolic time intervals was introduced in 1995 [4,5]. This index, represented by the sum of isovolumic relaxation time (IVRT) and isovolumic contraction time (IVCT) divided by left ventricular ejection time (ET), is reported to be a sensitive measure of global left ventricular performance. Myocardial performance index can be determined easily using conventional Doppler echocardiography.

Hence, this study was designed to evaluate the impact of MetS on global left ventricular function by using left ventricular myocardial performance index (LVMPI) and to compare it with healthy controls.

Abbreviations

MetS	metabolic syndrome
LVMPI	left ventricular myocardial performance index
IDF	International Diabetes Federation
IVCT	isovolumic contraction time
IVRT	isovolumic relaxation time
ET	ejection time
TDI	tissue Doppler imaging
PWD	pulse wave Doppler
BMI	body mass index
IFG	impaired fasting glucose
SBP	systolic blood pressure
DBP	diastolic blood pressure
DM	diabetes mellitus
FBS	fasting blood sugar
TGL	triglycerides
HDL-C	high density lipoprotein cholesterol
MPI	myocardial performance index

Materials and methods

We recruited 50 consecutive patients with MetS attending to the Cardiology Out-patient Department of Sri Venkateswara Institute of Medical Sciences into this prospective case-control study. The diagnosis of MetS was made as per the International Diabetes Federation (IDF) criteria [6]. According to this criteria, diagnosis of MetS was performed with waist circumference $\geqslant$90 cm for men or $\geqslant$80 cm for women (for South-Asian ethnic group) along with any two of the following: triglyceride (TGL) levels $\geqslant$150 mg/dL or treatment for elevated TGL, HDL Cholesterol (HDLC) levels $\geqslant$40 mg/dL for men or $\geqslant$50 mg/dL for women; blood pressure $\geqslant$130/85 mmHg or undergoing antihypertensive treatment, and fasting blood glucose levels $\geqslant$100 mg/dL or treatment for DM.

The study excluded patients aged above 60 years, patients with structural heart disease, including valvular and ischemic heart disease, patients with atrial fibrillation, atrial flutter and AV blocks, patients with other secondary causes of hyperlipidemia like hypothyroidism and renal insufficiency. Thirty age- and sex-matched healthy controls were recruited into the control cohort. Informed consent was obtained from each of the patients and controls following ethical guidelines of the 1975 Declaration of Helsinki. This study was approved by the Institutional Ethical Committee of Sri Venkateswara Institute of Medical Sciences, Tirupati, Andhra Pradesh, India.

Baseline assessment in all patients included a detailed history, physical examination, and cardiovascular examination. Risk factors like diabetes mellitus, hypertension and obesity were assessed. Anthropometric evaluation included waist circumference which was measured to the nearest centimeter, just above the iliac bones, with the subject standing using a flexible and non-distensible tape. Waist circumference >90 cm was considered as abdominal obesity. Blood pressure was measured twice with a three-minute interval after a 10-min rest with no tight clothes. The mean of the two measurements was recorded. Obesity was defined as body mass index (BMI) greater than 30 kg/m^2. Plasma glucose, serum triglycerides and serum HDL cholesterol levels were measured using commercially available kits on auto analyzer (Synchron CX9 from Beckman, USA).

Echocardiography was performed with a Philips IE33 (Philips, The Netherlands) machine using a 1–5 MHz transthoracic probe, according to the guidelines of the American Society of Echocardiography [7]. A parasternal long axis view approximately at the level of the mitral valve leaflet tips was used to measure LV wall thickness, end systolic and end diastolic dimensions. The mitral inflow velocity pattern was recorded in the apical 4-chamber view with the pulsed wave Doppler sample volume positioned at the tip of mitral leaflets during diastole. The left ventricular outflow velocity pattern was recorded in the apical 5-chamber view with the pulse wave Doppler volume positioned just below the aortic valve [8].

Both ventricular inflow and outflow patterns were recorded at 100 mm/s sweep speed. Doppler measurements were obtained by an average of five consecutive beats as described by Quiñones et al. [8]. Doppler time intervals were measured from the mitral inflow and left ventricular outflow velocity time intervals. The interval between mitral valve closure and opening corresponds to the time from cessation to onset of mitral inflow and is equal to the sum of IVCT, ET, and the IVRT. Left ventricular ejection time was measured as the duration of the left ventricular outflow velocity profile. Then, myocardial performance index