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Echocardiographic Epicardial Fat Thickness among Metabolic Syndrome Patients with Its Determinants

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Abstract **Background:** Echocardiographic epicardial fat thickness may be associated with metabolic syndrome. **Objective:** The purpose of the present study was to see the association of epicardial fat thickness with metabolic syndrome. **Methodology:** This comparative cross-sectional study was conducted in the Department of Cardiology at National Institute of Cardiovascular Diseases, Dhaka, Bangladesh from April 2017 to March 2018 for a period of one year. Depending on the diagnosis of metabolic syndrome (MetS), patients were divided into two groups, group I patients with MetS and group II patients without MetS. The epicardial fat thickness of group I and group II were prospectively examined by echocardiography. Then the comparison of the epicardial fat thickness was done between the two groups. **Result:** A total of 130 patients were included in this study of which 65 patients were assigned in group I and the rest of 65 patients were assigned in group II. The mean age of group I and group II patients were 44.4±9.8 years and 43.7±10.2 years (p = 0.77). The mean epicardial fat thickness (mm) was found significantly higher in patients with metabolic syndrome than in patients without metabolic syndrome which was 5.7 ± 0.83 mm and 2.7 ± 0.86 mm (p=0.001). The analysis had revealed that BMI, LDL, HDL, FBS, WC, age and diagnosis of metabolic syndrome were the independent determinants of increased epicardial fat thickness (p<0.05). **Conclusion:** In conclusion metabolic syndrome is associated with increased echocardiographic epicardial fat thickness.

Keywords: *association, echocardiography, epicardial fat thickness, metabolic syndrome, lipid profiles*

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1. Introduction

The concept of metabolic syndrome has existed for many years [1]. It refers to a clustering of metabolic risk factors including central obesity, glucose intolerance, dyslipidemia and hypertension [2,3]. However, there are multiple agreed definitions of metabolic syndrome and, hence, estimates of metabolic syndrome vary substantially across populations depending on the definition used. Expert Groups from the World Health Organization [4], European Group for the Study of Insulin Resistance [5], National Cholesterol Education Program Expert Panel, Adult Treatment Panel III, American Association of Clinical Endocrinologists and the International Diabetes Federation (IDF) Consensus Group have published different definitions [6]. Among these definitions, only the modified NCEP ATP III and the IDF definitions have suggested that the cut-off points of waist circumference should be ethnic-specific, and individuals of Asian origin should use the cut-off values less than that of the western population [7].

It is very important to know the epicardial fat thickness among the metabolic syndrome patients. Echocardiographic epicardial fat thickness varies from a minimum of 1 mm to a maximum measured value of almost 23 mm [8]. The wide range of epicardial fat thicknesses likely reflects the substantial variation in abdominal visceral fat distribution. Iacobellis et al [8] found the median epicardial fat thicknesses of 9.5 mm and 7.5 mm as the cut-off points of high abdominal fat in men and women, respectively. Jeong et al [9] reported a mean epicardial fat thickness of 6.3 mm in >200 subjects who underwent coronary angiography.

Echocardiographic epicardial fat thickness is a linear measurement at a single location and therefore may not reflect the variability of fat thickness or total epicardial fat volume [10]. Although the anterior layer of epicardial fat is the one commonly measured by echocardiography, this

region may have variability in fat content. Epicardial fat thickness is usually lesser in the vicinity of the mid right ventricular free wall and greater in the distal portion of the right ventricular free wall. Echocardiographic measurements of epicardial fat thickness in the atrioventricular groove or interventricular groove areas may give a more accurate assessment of epicardial fat amount [11]. To overcome these limitations most of the researchers recommend measurement of epicardial fat at end systole in two different views [8,12,13]. Therefore, echocardiographic epicardial fat thickness could be a reliable marker of visceral adiposity. In this context this present study was undertaken to see the association of epicardial fat thickness with metabolic syndrome patients as well as their determinants.

2. Methodology

2.1. Study Population & Settings

This analytic type of cross-sectional study was carried out in the Department of Cardiology at National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh from April 2017 to March 2018 for a period of one (01) year. All patients more than or equal to 18 years old in both sexes attended in the indoor and outdoor echocardiography department of NICVD for echocardiography during the specified period were selected as the study population. The samples were collected by purposive sampling method. Patients with moderate to severe valvular heart disease, congenital heart disease and cardiomyopathy, patients with acute coronary syndrome (ACS), patients who were on lipid lowering drugs, history of taking corticosteroid or other weight gaining drugs, patients with pericardial effusion, patients with ascites and or edema or patients with poor echo window were excluded from this study. The study protocol was approved by Ethical Review Committee of NICVD.

2.2. Study Procedure

Informed written consent was a mandatory prerequisite for every patient. Echocardiography was done (Siemens Acuson X 700) and epicardial fat thickness was measured by 2-D echocardiography in two different views i.e. in parasternal long axis (PLAX) view and in parasternal short axis (PSAX) view at mid-ventricular level. Two cardiologists expert in echocardiography, measured the fat thickness would be unaware about the clinical and laboratory parameters of the patients. Data were collected by using a preformed data collection sheet. MetS was diagnosed on the basis of modified NCEP ATP III definition. Depending on the diagnosis of MetS, patients were divided into group I and group II. In group I the patients with metabolic syndrome were included and in group II patients without metabolic syndrome were included.

2.3. Statistical Analysis

The epicardial fat thickness among the groups were Compared and analyzed. The numerical data obtained from the study was analyzed and significance of differences was estimated by using statistical methods. Continuous variables were expressed as mean values with standard deviation and compared using Student's t-test. Categorical variables were expressed as frequencies with percentages and compared using Chi-square test or Fisher's exact test. Logistic regression analysis was performed to adjust for the potential confounders in predicting the association. Statistical significance will be assumed if $p < 0.05$. Statistical analyses were carried out by using SPSS 23.0 (Statistical Package for the Social Sciences by SPSS Inc., Chicago, IL, USA, 2015).

3. Result

A total of 130 patients were included in this study. On the basis of the diagnosis of metabolic syndrome, the study subjects were divided into two groups of which 65 patients who had fulfilled the diagnosis of metabolic syndrome were assigned in group I and another 65 patients who did not fulfill the diagnosis of metabolic syndrome were assigned in group II. Mean age of the studied patients was 44.1± 9.9 years. The mean age of patients with metabolic syndrome was 44.4±9.8 years and the mean age of patients without metabolic syndrome was 43.7±10.2 years. There was no significant difference ($p = 0.77$) among the metabolic and non-metabolic syndrome groups in respect to their age. Among the metabolic syndrome group, the highest frequency was in the age group of 41 to 50 years (35.0%) followed by 31 to 40 years (31.0%), 51 to 60 years (20.0%) and ≤30 years (05.0%). Similar pattern was also noted in the non-metabolic syndrome group (Table 1).

Table 1. Comparison of the study groups according to their age (n=130)

Age Group	Group I	Group II	Total	P value
≥30 Years	6(9.0%)	6(9.0%)	12(9.0%)	
31 to 40 Years	20(31.0%)	21(32.0%)	41(32.0%)	
41 to 50 Years	24(35.0%)	23(35.0%)	47(36.0%)	
51 to 60 Years	13(20.0%)	11(19.0%)	19(18.0%)	
More than 60 Years	3(5.0%)	3(5.0%)	6(5.0%))	
Total	65	65	130	
Mean ± SD (age in years)	44.4±9.8	43.7 ± 10.2	44.1 ± 9.9	0.77^{ns}

MetS = Metabolic syndrome; ns = Not significant ($p > 0.05$); p value of mean age reached from unpaired t-test.

The mean epicardial fat thickness (mm) was found significantly higher in patients with metabolic syndrome than in patients without metabolic syndrome which was 5.7 ± 0.83 and 2.7 ± 0.86 (p=0.001) (Table 2).

Table 2. Comparison of the study groups by epicardial fat thickness (n = 130)

Group	Mean ± SD	P value
Group I	5.7 ± 0.83	0.001[s]
Group II	2.7 ± 0.86	

s = Significant (p <0.05); Data were analyzed using unpaired t-test.

The multivariate stepwise linear regression analysis was performed to see the determinants of epicardial fat thickness. The analysis had revealed that BMI, LDL, HDL, FBS, WC, age and diagnosis of metabolic syndrome were the independent determinants of increased epicardial fat thickness (p<0.05). Among them BMI and HDL were highly significant (p<0.001). It was expected that each unit (Kg/M^2) increased in BMI had caused 0.256 mm increase in epicardial fat thickness. Negative β value in case of HDL had indicated each unit (mg/dL) decrease in HDL had caused 0.088 mm increase in epicardial fat thickness. For rest of the variables each unit had increased in the respective variables (LDL, FBS, WC, Age and diagnosis of metabolic syndrome) also caused 0.141mm, 0.202 mm, 0.057mm, 0.021 mm, 0.136 mm increase in epicardial fat thickness (Table 3).

Table 3. Multivariate Stepwise Linear Regression Analysis for the Determinants of Epicardial Fat Thickness

Variables	β	P value	95% CI
BMI	0.256	<0.001[s]	(0.134 to 0.378)
LDL	0.141	0.002[s]	(0.050 to 0.230)
HDL	-0.088	<0.001[s]	(-0.127 to -0.047)
FBS	0.202	0.005[s]	(0.063 to 0.342)
WC	0.057	0.019[s]	(0.009 to 0.104)
Age	0.021	0.026[s]	(0.004 to 0.040)
Diagnosis of MetS	0.136	0.002[s]	0.196)

Dependent variable = Epicardial fat thickness; BMI = Body mass index; LDL = Low density lipoprotein; HDL = High density lipoprotein; MetS = Metabolic syndrome; FBS = Fasting blood sugar; WC = Waist circumference; SRC: Standard regression coefficient; s = Significant (p <0.05)

4. Discussion

This study has been performed with an aim to find out the association of echocardiographic epicardial fat thickness with metabolic syndrome. A total of 130 patients who agreed to do echocardiography were included in the study. Anthropometric parameters and blood pressure were measured and relevant investigations were sent. On the basis of the diagnosis of metabolic syndrome, the study subjects were divided into two groups. 65 patients who fulfilled the diagnosis of metabolic syndrome were assigned in group I and another 65 patients who did not fulfill the diagnosis of metabolic syndrome were assigned in group II.

The mean age of the whole study population was 44.1 ± 9.9 and the mean age of metabolic and non-metabolic syndrome groups were 44.4 ± 9.8 and 43.7 ± 10.2 respectively. The difference of age in between the groups was not significant statistically (p = 0.77). In some of the studies done at NICVD supports the mean age of this study [14,15]. In an Indian study undertaken by D. S. Prasad and colleagues found the mean age was 45.9 ± 13.9 which was very close to our study population [15]. However, they found a significant difference in mean age between metabolic and non-metabolic syndrome groups i.e. 51.66 ± 11.9 vs. 41.55 ± 13.8. The reason behind this significant difference is that the mentioned study was an epidemiological study undertaken to measure the prevalence of metabolic syndrome. A very consistent finding is that the prevalence of the metabolic syndrome is highly age-dependent. This pattern is clear in Iran where the prevalence is less than 10% for both men and women in the 20–29 year age group, rising to 38% and 67%, respectively, in the 60–69 year age-group [16]. Similarly, in a French population, the prevalence rises from <5.6% in the 30–39 year age-group to 17.5% in the 60–64 year age group[16]. Additionally, the prevalence of the metabolic syndrome in the USA (national health and nutrition examination survey [NHANES III]) increased from 7% in participants aged 20–29 years to 44.0% and 42.0% for those aged 60 to 69 years and at least 70 years, respectively [17].

The epicardial fat thickness was studied among metabolic and non-metabolic syndrome patients. The mean epicardial fat thickness (mm) was found significantly higher in patients with metabolic syndrome than in patients without metabolic syndrome (p=0.000). Faroque [18] found the mean epicardial fat thickness 7.14 ± 1.81 in patients with significant CAD at Dhaka Medical College Hospital, Dhaka, Bangladesh. The mean was relatively higher in this study probably because the study population had established CAD and other risk factors of cardiovascular disease. Another study done by Okyay et al [19] found the mean epicardial fat thickness 5.1 ± 1.7 in metabolic syndrome patients which is consistent with our study. In another study it has been reported that the median epicardial fat thickness in metabolic syndrome group is 9.5 mm and in non-metabolic syndrome group was 4.5 mm [13]. In this western population based study, the mean BMI was 32 Kg/M^2 that explain the relative higher value of epicardial fat thickness.

The multivariate stepwise linear regression analysis of determinants of echocardiographic epicardial fat thickness was measured in this study. The analysis revealed that BMI, LDL, HDL, FBS, WC, age and diagnosis of metabolic syndrome were the independent determinants of increased epicardial fat thickness (p<0.05). Among them BMI and HDL are highly significant (p<0.001). It is expected that each unit (Kg/M^2) increase in BMI causes 0.256 mm increase in epicardial fat thickness. Negative β value in case of HDL indicates each unit (mg/dL) decrease in HDL causes 0.088 mm increase in epicardial fat thickness. For rest of the variables each unit increase in the respective variables (LDL, FBS, WC, Age and diagnosis of metabolic syndrome) also causes 0.141mm, 0.202 mm, 0.057mm, 0.021 mm, 0.136 mm increase in epicardial fat thickness. One of the interesting finding in this study was the independent relation of epicardial fat thickness with metabolic syndrome in spite of the

inclusion of its components in the regression model. Similar type of results were found in a study conducted by Okyay et al [19] where BMI, LDL, WC, age, diagnosis of metabolic syndrome and triglyceride level were independent determinants of epicardial fat thickness.

5. Conclusion

In conclusion metabolic syndrome is associated with increased echocardiographic epicardial fat thickness. It can also said that BMI, LDL cholesterol, HDL cholesterol, FBS, WC, age and diagnosis of metabolic syndrome are independent determinants of epicardial fat thickness.

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