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Prevalence of Metabolic Syndrome in Patients with Coronary Artery Disease Presenting to a Tertiary Care Hospital

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Abstract: ***Background: Metabolic syndrome (MS) is represented by a cluster of risk factors associated with insulin resistance, subclinical inflammation, increased future risk of diabetes, and coronary artery disease (CAD). Hence the present study was undertaken to determine the prevalence of metabolic syndrome and its components in patients with CAD. Method: In this cross-sectional study, a total 250 patients of either sex, age between 28-82 years diagnosed with CAD by medical, clinical and angiography findings were studied over a period of 6 month. MS components were defined according to the modified Adult Treatment Panel III (ATP III) criteria. Results: The metabolic syndrome was present in 50.8% of patients and was more frequent in women than in men (56.69% vs. 43.30%; P < .005). The prevalence increased with age. Low high-density lipoprotein cholesterol (HDL-C) (85.3%), high fasting blood glucose (FBG) (78.8%) and high waist circumference (WC) (76.3%) were the most prevalent risk factors in CAD patients with MS as compared to those without MS. Conclusion: The present study clearly indicates a high prevalence of MS in patients with CAD and significantly higher prevalence in women than in men. The three components of MS including low HDL-C, high blood glucose and abdominal obesity were the strongest predictors of CAD but additional studies are required to clarify the results.***

Keywords: Metabolic syndrome, Coronary artery disease, Angiography, Lipoprotein, Cholesterol, Glucose, Waist circumference, Predictors

1. Introduction

Coronary artery disease (CAD) is the leading cause of morbidity and mortality in both developing and developed countries. Approximately, one-sixth of world's population lives in India and CAD remains the highest cause of mortality in India [1]. Deaths related to CAD occur 5 to 10 years earlier in Indian sub-continent than in Western countries [2].

The metabolic syndrome (MS) is a combination of interrelated metabolic abnormalities that significantly increase the risk of cardiovascular disease, and type 2 diabetes mellitus (DM2) [3,4]. The prevalence of MS has been rising alarmingly in recent times due to decreased physical activity and abnormal dietary patterns [5]. Patients with MS have a 30 - 40% probability of developing CAD within 20 years depending upon number of components present [6]. Each component of MS is individually associated with an increased risk of cardiovascular disease; however, whether MS leads to greater cardiovascular risk than the sum of its components remains a matter of debate [7]. It has been suggested that the number of MS components may be more useful in predicting cardiovascular disease than MS itself, since cardiovascular risk increases as the number of components increases [8]. Similarly, given the heterogeneity of MS, the impact of the possible combinations of its components on predicting cardiovascular risk has been investigated.

There are different criteria for the identification of metabolic syndrome. It is diagnosed through the assessment of blood sugar, lipid levels, blood pressure, waist circumference/BMI utilizing the criteria suggested by World Health Organization (WHO), National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III) and International Diabetes Federation (IDF) [9]. Asian Indians have a smaller build and predominant abdominal adiposity as compared with Caucasians. Hence, modified recommendations for the diagnosis of metabolic syndrome have been proposed. The recommended lower BMI cut-off for defining 'overweight' in Asian Indians is 23 kg/m^2, modified WC measures is ≥94 cm and ≥80 cm and a waist–hip ratio (WHR) of 0.89 and 0.81 for men and women, respectively [10]. The International Diabetes Federation (IDF) has defined 90 cm and 80 cm as cut offs for determining abdominal obesity in Asian men and women, respectively [11, 12].

The present study was undertaken to determine the prevalence of metabolic syndrome and its components in patients with coronary artery disease who underwent elective coronary angiography.

2. Materials and Methods

This cross-sectional study was conducted on 250 patients of either sex, aged between 28-82 years, admitted in the Cardiology Department of a tertiary Care Hospital, and diagnosed to be suffering from Ischemic heart disease (IHD) by the cardiologist, during a period of 6 months from January to June 2019. All the patients diagnosed with IHD by previous medical history, clinical examinations and electrocardiogram (ECG) changes; were further subjected to

coronary angiography and diagnosed to have coronary artery disease(CAD). Patients with chronic heart failure and acute coronary syndrome (ACS) who needed emergent coronary intervention or surgery, those suffering from hepatic and kidney diseases, hyperthyroidism and pregnant women were excluded from the study.

The study was done after obtaining institutional ethical committee clearance and informed consent. The demographic data including age, sex, physical activity, and previous medical history and medications were obtained by patient's self report. The age was categorized as < 50 and ≥ 50 years old. Physical activity was classified into three categories: no activity , < 30, and ≥ 30 min walking for at least three times a week [13]. The weight and height of patients were recorded by a Seca scale (Germany) to the nearest 0.5 kg and 0.5 cm, respectively. Body mass index (BMI) was calculated as weight (kg)/height (m2). WC was measured in the standing position using an inelastic measuring tape to the nearest 0.5 cm between the lower border of the rib cage and the iliac crest [14]. Blood pressure (BP) was measured in the sitting position in the right arm using a digital manometer after at least 5 minof rest. Two recordings were taken, and the mean levels of BP were used for analysis.

The blood samples were obtained after overnight fasting. Serum levels of total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), Triglyceride (TG) and fasting blood glucose (FBG) were assayed by enzymatic procedures using an auto-analyzer. Metabolic syndrome was diagnosed according to the ATP III criteria and IDF consensus, including three or more of the following metabolic abnormalities: abdominal obesity (waist circumference [WC] with cut-off value of ≥ 90 cm and 80 cm cm for male and female respectively), high blood pressure (≥130 mmHg systolic or ≥85 mmHg diastolic), hypertriglyceridemia (TG ≥150 mg/dl), low high density lipoprotein cholesterol (HDL‑C) (<40 mg/dl, in men and <50 mg/dl in women), high fasting glucose (fasting serum glucose (≥100 mg/dl) [15].

Statistical analyses

Statistical analyses were performed using Statistical Package for the Social Sciences version 21. Data were presented as mean ± standard deviation (SD), frequencies and percentages. Chi-square and Student's t-test were used for statistical analysis. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for MS and individual components of it. Multivariable linear regression model, adjusted for sex, was used to evaluate the association between variables. P < 0.05 was considered significant.

3. Observations and Results

Total 250 CAD patients were enrolled in the study, among them 112 (44.8%) were males and 138 (55.2%) were females. The mean age of the patients was 57.47±8.53 years, ranging from 28-82 years. The demographic and clinical characteristics of the 250 CAD patients with and without metabolic syndrome are presented in Table 1; of these, 50.8% (127 cases) had metabolic syndrome; (72; 56.69% females vs. 55; 43.30% males) (P < 0.05). The highest prevalence was present in patients aged > 50 years (84%, P < 0.05). The mean WC, BMI and BP, serum levels of FBG and cholesterol, TG and LDL-C in CAD patients with MS were significantly higher and HDL-C levels (P < 0.001) were significantly lower than in those without MS.

Table 1: Demographic and clinical characteristics of the 250 CAD patients

Characteristics		Group		P value
		With MS	Without MS	
Age (Years), n (%)	<50	19 (14.96%)	41 (33.33%)	-
	>50	108 (85.03%)	82 (66.66%)	
Mean age (Years)		57.58±7.9	57.26±21.4	0.87
Sex, n (%)	Males	46 (41.07%)	66 (58.92%)	-
	Females	80 (57.97%)	58 (42.02%)	
Physical Activity, n (%)	No activity	73 (57.48%)	54 (43.90%)	-
	≤30 min	32 (25.19%)	41 (33.33%)	
	>30 min	22 (17.32%)	28 (22.76%)	
BMI (kg/m^2)		27.21±3.4	23.37±4.7	0.0001
WC (cm)		108±15.3	86.78±21.3	0.0001
BP (mm Hg)	Systolic	137.67±14.2	127.78±18.2	0.0001
	Diastolic	87±12.3	78±13.2	0.0001
FBG (mg/dl)		137.46±57.2	111±51.6	0.001
Cholesterol (mg/dl)		162.8±45.3	132.8±37.1	0.001
TG (mg/dl)		163±87	112.3±24	0.0001
LDL-C (mg/dl)		88.35±37	77.47±13	0.001
HDL-C (mg/dl)		43±15.6	48±13.4	0.001

Low HDL-C (85.3% vs. 67.24%, P < 0.01), high FBG (78.8% vs. 31%, P < 0.0001), and high WC (76.3% vs. 11.7%, P < 0.0001) were the most prevalent risk factors in CAD patients with MS as compared to those without MS, (Figure 1). The odds ratio (ORs) for main components of MS in CAD patients with MS were low HDL-C (OR-13.55; 95% CI- 5.7 - 21), high WC (OR- 7.3; 95% CI- 4.1 - 12.0), high FBG (OR- 7.5 ; 95% CI- 6.0 - 9.3), high TG (OR- 2.16; 95% CI- 1.1 - 3.23), and high BP (OR- 1.21; 95% CI- 1.03 - 1.7).

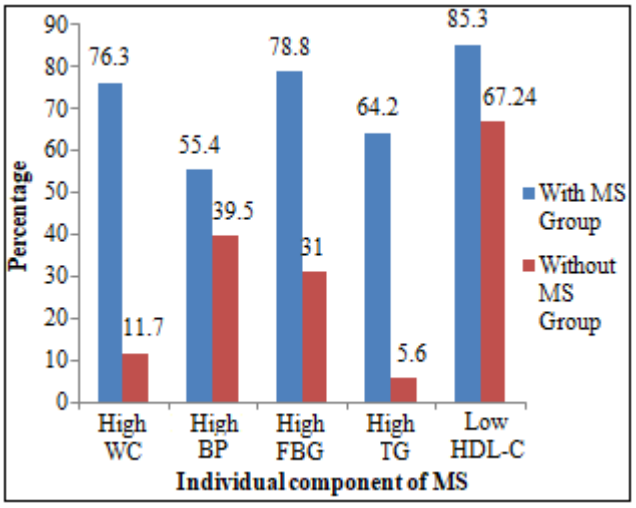

Figure 1: Prevalence of individual components of MS in CAD patients

Table 2 demonstrates that after adjusting for sex, based on multivariable linear regression analysis, the high WC (β = 0.662, P < 0.0001), high BP (β = 0.20, P < 0.05), high FBG (β = 0.15, P < 0.01), high TG (β = 0.194, P < 0.01) and low

HDL-C (β = 0.19, P < 0.0001) were found as significant predictors of MS in CAD patients.

Table 2: Multivariate Linear Regression Analysis between MS and the Coronary Risk Factors

Parameters	Unstandardized coefficients		Standardized coefficients beta	t value	P value
	B	Standard error			
Older Age	0.003	0.004	0.08	1.240	0.211
High BMI	0.013	0.009	0.105	1.318	0.189
High WC	0.021	0.004	0.662	7.501	0.0001
High BP	0.005	0.003	0.201	2.391	0.024
High FBG	0.001	0.000	0.151	2.603	0.01
High Cholesterol	0.000	0.001	0.034	0.457	0.661
High TG	0.001	0.000	0.194	3.216	0.002
High LDL-C	0.001	0.001	0.033	0.610	0.559
Low HDL-C	0.008	0.003	0.198	3.867	0.0001

4. Discussion

In the past few decades, increased attention given to MS has led to several attempts to develop a definition that is accepted worldwide. However, there is as yet no internationally agreed definition for MS and, hence, prevalence of MS varies substantially depending on the criteria used. The World Health Organization (WHO) proposed a set of diagnostic criteria in 1998 [16] followed by definitions from the National Cholesterol Education Program's Adult Treatment Panel III (ATP-III) [17] and the International Diabetes Federation (IDF) [4]. These definitions agreed that hyperglycemia, obesity, dyslipidaemia, and hypertension are core components of MS, but they differed in the details and criteria. In 2005, a modification (ATP-III) by the American Heart Association and National Heart, Lung, and Blood Institute (AHA/NHLBI) was proposed with a reduced threshold for hyperglycemia and some minor modifications [3].

Earlier studies using NCEP ATP III criteria and c have shown prevalence of MS among Indian population to range from 18.3% to 41% [18, 19]. However, this prevalence increases dramatically in patients with CAD. Globally, among the elderly population, MS prevalence is high and ranges from 45-65% [20] depending on the population studied and criteria used to define MS. In the present study, the prevalence of metabolic syndrome in angiographically confirmed CAD patients was 50.8% which is similar to studies in other regions of the world like in study by Jover et al., in which prevalence was 50.9% in Spanish population,[21] while in Iranian adults the prevalence of metabolic syndrome among CAD patients was 49.5% [22]. Hence, the prevalence of MS varies widely, depending on the type of study (hospital‐based vs. population‐based study), baseline characteristics of the study population (e.g., ethnicity, age, and history of ACS) and criteria used to define MS. Furthermore, these differences could be due to lifestyle‐related factors such as unhealthy food habits, urbanization, economic growth, physical inactivity and increased stress, high percentage of body fat, and abdominal obesity.

This study also indicated that the prevalence of MS is more common in women than men (56.69% versus 43.30%) in patients with CAD. This finding is of significant concern because studies have shown decreased survival in women with MS compared to women without MS [23]. Previous studies have reported mixed results regarding predisposition of sex to development of MS. Some have indicated increased prevalence in females [24, 25]; others have indicated increased prevalence in men [18, 19] while a study in US reported little difference in prevalence in general population between men and women [26].

The individual components of the metabolic syndrome whether alone or in combination with risk factors have variable effects on CAD risk with some of them having the highest risk for CAD, however, each component acts as an independent risk factor for CAD, but all of them interact synergistically, and thus lead to increased risk of CAD [27]. The prevalence of metabolic syndrome and its individual components with various rates in CAD patients has been reported in earlier studies, the abdominal obesity, dyslipidemia, HT, and hyperglycemia most often were reported as the metabolic syndrome components, and the severity of CAD increased with the number of components [28, 29]. While assessing the various components of MS in patients with the syndrome, we found that all patients had significantly higher BMI, WC, BP, serum lipid profile, and FBG, and lower HDL-C levels as compared with nonmetabolic syndrome patients. Low HDL-C was the most frequently seen risk factor (85.3%). These findings are correlated well with the prior studies [30, 31] The regression analysis revealed that the rate of different components of MS, including higher rate of low HDL-C, high blood glucose and high WC, with the highest OR, and a relatively high prevalence of high TG and high BP was found in patients with MS than those without MS. The mean of both BMI and WC in patients with MS was significantly higher than those without MS; however, after adjusting of sex, based on multivariable linear regression analysis, a positive significant association was found only between WC and MS, suggesting that the fat distribution in the abdomen is more atherogenic than peripheral obesity and may predict the risk of CVD [32].

5. Conclusion

The present study clearly indicates a high prevalence of MS in patients with CAD and significantly higher prevalence in women than in men. Three components of MS including low HDL-C, high blood glucose and abdominal obesity, were the strongest predictors of CAD; however, older age, physical inactivity and female gender also had predictive value. Although after adjusting of sex, there was no statistically significant relationship between the categories of age and physical activity with the MS in the CAD patients. These variables were significantly higher among CAD patients with MS than in those without MS.

The study suggested that the combination of all components of MS may be a secondary contributor to CAD risk. Therefore, health prevention programs are recommended to modify preventable components of metabolic syndromes to reduce the risk of CAD.

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