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ORIGINAL ARTICLE

Coronary Artery Lesions and Calcium Scoring in Patients with Metabolic Syndrome Detected by Multislice CT Coronaries

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ABSTRACT

Metabolic syndrome is a complex disorder formed by many factors that increase the risk of coronary heart disease, many forms of atherosclerotic cardiovascular diseases, and diabetes mellitus type 2 . Detecting coronary artery lesions in an asymptomatic patient with multiple cardiovascular risk factors in a trail to closely follow up that patient to prevent the development of the overt coronary problem. This work aimed to assess calcium scoring in patients with metabolic syndrome, determine the severity of CAD and determine the type and extent of plaque.

Methods: The study was carried out at Zagazig University Hospitals and Kobryn El Oubba Military Hospitals, Cairo, Egypt, during the period from January 2017 to July 2018. The study protocol was approved by the Department of Cardiology at Zagazig University and the Ethical committee of the faculty of medicine. 60 patients having metabolic syndrome diagnosed according to ATP III were researched.

Results: The study showed that there is a statistically significant increase in coronary artery calcium in patients with metabolic syndrome and statistically significant data between the prevalence of coronary artery calcium and an increase in several metabolic syndrome components.

Conclusions: Metabolic syndrome is significantly associated with the presence and extent of coronary calcifications and lesions even in asymptomatic patients.CAC screening is an accurate and valuable modality as a completely non-invasive and relatively time-efficient screening way provided avoid the high radiation burden on patients.

Keywords: Coronary Calcium Score, Computed Tomography, Metabolic Syndrome, Coronary Artery Disease.

INTRODUCTION

Metabolic syndrome (MetS) is a compound disease that is deemed to be a global epidemic. Mets is a group of risk factors that increase the risk of coronary heart disease (CHD), other forms of cardiovascular atherosclerotic diseases (CVD), and diabetes mellitus type 2 (DMT2). Its main compositions are dyslipidemia in form of (elevated triglycerides and apolipoprotein B (apo B)-containing lipoproteins, low high-density lipoproteins (HDL), the elevation of arterial blood pressure (BP), and dysregulated glucose homeostasis, whilst abdominal obesity with/out insulin resistance (IR) have been the cornerstone of the syndrome· [1-3]

Several expert groups have developed clinical criteria for the Mets. They all agreed on the main components of the metabolic syndrome: obesity, dyslipidemia, IR, and hypertension. [4,5]

The three components of dyslipidemia (high blood triglyceride (TG) levels), increased low-density lipoprotein (LDL) and decreased high-density lipoprotein (HDL) are separately associated with a cardiovascular risk that can lead to the formation of plaques in arteries. These plaques may cause arteries to narrow and harden, which can lead to an ACS or stroke. [6]

Mets have been associated with atherosclerosis in some epidemiological studies. It is important to investigate the prevalence of MetS and its components and study the association of Mets with subclinical atherosclerosis. The presence and extent of coronary artery calcium (CAC) are strongly correlated with the magnitude of coronary atherosclerotic plaque burden and subsequent coronary events. [7]

Coronary artery disease is considered one of the leading causes of death worldwide. Measuring the amount of CAC with CCTA is not only a noninvasive technique for screening risk of future cardiac events but also a reliable method [8,9] using many scores in calculating the amount of

calcium such as the Agatston score [10], the volume score [11] and calcium mass. [12] Many studies showed that the amount of CAC measured by the Agatston score is a strong predictor of the risk of myocardial infarction and sudden cardiac death, unaided by standard risk factors. [13-15].

METHODS

This study was carried out in Zagazig University Hospitals and Koby el Oubba Military Hospitals on 60 asymptomatic patients having metabolic syndrome according to ATP III definition [16] from January 2017 to July 2018. The study protocol was approved by the Department of Cardiology at Zagazig University and the Ethical committee of the faculty of medicine. The work has been carried out by The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans. Also, written formed consent was obtained from all participants.

Inclusion criteria: Asymptomatic patients having metabolic syndrome diagnosed according to ATP III, Any patient having 3 or more of the following features: Central obesity based on waist circumference ≥102cm for males and ≥ 88 cm for females and/or BMI >30, Raised fasting triglycerides ≥150 mg/dl, Reduced high-density lipoprotein cholesterol < 40mg/dl for males or <50 mg/dl for females, Raised blood pressure ≥130mmhg systolic or ≥85mmhg diastolic or previously diagnosed with hypertension, Raised fasting plasma glucose ≥110mg/dl or previously diagnosed type 2 DM.

Exclusion Criteria: Patients with renal insufficiency (S.creatinine>1.5 mg/dl), Patients with a previous history of PCI or previous CABG, Patients with dye allergy, Patients with irregular heart rate like AF and frequent extrasystoles.

The following diagnostic workup was carried out on all study populations:

Full medical history, Full clinical examination, Blood sample and chemistry, Waist circumfluence Body mass index, Electrocardiography (ECG), Coronary CT scanning protocol, Coronary artery calcium scoring

Statistical analysis :

Data collected throughout history, basic clinical examination, laboratory investigations, and outcome measures were coded, entered, and analyzed using Microsoft Excel software. **W**e used the **R** language (R-studio Version 0.99.484 – © 2009-2015) for data analysis. Continuous Variables are expressed as mean ±SD while categorical variables are expressed in frequency and percentage. Differences in frequency of characteristics were assessed by independent sample student's t-test for continuous variables, while Chi-square statistics were used for discrete variables. A two-tailed P-value, of 0.05 was considered statistically significant.

Variables that had not fulfilled the normal distribution frequency conditions were treated by non-parametric tests (Mann Witney test) or (Wilcoxon test).

Logistic regression analysis was done to model the dependent and independent variables and make a univariate analysis; a P-value of 0.05or less was considered statistically significant.

RESULTS

The percentage of risk factors among the study group. HTN was 72%, DM was 48%, smoking was 53% and Family History was 75% (**Table** 1). CAC score was high in 56% of studied patients **(Table 2).**

The association between metabolic syndrome criteria and the presence of CAC. Coronary calcium was statistically significant among those with increased waist circumference (P-value 0.001) and those with reduced HDL (P-value 0.021) **(Table 3).**

The correlation between the severity of coronary artery disease and the number of metabolic syndrome risk factors. Increasing the number of metabolic syndrome components was associated with a high CAC score (P-value 0.002) (**Table 4**).

Smoker shows a high CAC score in comparison with nonsmoker and this difference was statistically highly significant (P-value 0.001) (**Table 5**)

Increasing age, high levels of plasma LDL, and increasing waist circumfluence are independent risk factors for the increase in CAC deposition as measured by the Agatston score (P-value 0.000)**. (Table 6).**

Increasing age, hypertension, and central obesity are independent risk factors for the increase in CAC deposition as measured by Calcium Score. (P-value 0.000) **(Table 7).**

Table (1): Percentage of risk factors among the study population

Risk factor	No	%
HTN	43	71.66%
Diabetic	29	48.33%
Smoking	45	75%
Family history of IHD	32	53.33%

Table (2): Coronary Artery Calcium among the study group

CAC	No.	%
Negative	26	43.33%
Positive	34	56.66%

Table (3): Association between the presence of coronary calcium and metabolic syndrome criteria defined by ATP III

		No coronary calcium		Coronary calcium		X^2	P
		No.	%	No.	%		
HTN	+ve 43	17	28.33	26	43.33	0.73	0.51
	-ve 17	9	15	8	13.33		
DM	+ve 29	13	21.66	16	26.66	0.01	0.99
	-ve 31	13	21.66	18	30		
HDL	>40 M	22	36.66	18	30	5.30	0.021*
	>50 F						
	< 40 M	4	6.66	16	26.66		
	< 50 F						
TG	< 150	5	8.33	3	5	0.62	0.43
	> 150	21	35	31	51.66		
WC	94-102M	26	43.33	14	23.33	20.37	0.001*
	80-88F						
	>102cm	0	0	20	33.33		
	> 88cm						

Table (4): Correlation between number of affected vessels and number of metabolic risks

Number of affected vessels	r	P
Number of metabolic risks	0.395	0.002*

Table (5): Effect of smoking on CAC score

Total CAC		Median	Z	P-value
Smoking	Negative (n=14)	40.25	0.92	0.001*
	Positive (n=46)	13	-0.92	

Table (6): Multiple linear regression analysis of metabolic syndrome component and CAC measured by Agatston score

Variable	B (estimate)	S.E	P-value
Intercept (α)	-579.3185	86.2812	0.0000000111
Age	3.8662	0.6182	0.0000000623
LDL	3.8662	0.2182	0.04358
WC	3.4458	0.9988	0.00108

Table (7) Multiple linear regression analysis of metabolic syndrome component and CAC measured by Calcium score

Variable	B (estimate)	S.E	P-value
Intercept (α)	-534.8473	82.301	0.0000000249
Age	3.6840	0.5864	0.000000056
Total cholesterol	0.2066	0.1114	0.04903
WC	3.2195	0.9540	0.00136

DISCUSSION

Metabolic syndrome is an interconnection between many cardiovascular risk factors for obesity, hypertension, dyslipidemia, and IR. The incidence of cardiovascular disease is yet to be high in the era of such many risk factors [17] Coronary artery calcification is strongly correlated with the magnitude of coronary atherosclerotic plaque burden and with the development of subsequent events. The extent of Coronary artery calcification has been shown in several studies to predict cardiac events in asymptomatic individuals. [18] Previous studies have shown that CAC score assessment coupled with risk factors among asymptomatic adults provides more prognostic information, and the combined approach can guide primary preventive strategies for patients with CAD risk factors more accurately [19]

In the current study, we evaluated the relationship between metabolic syndrome components, as defined by ATP III, and the presence and extent of coronary calcification. In the present study, the prevalence of coronary artery calcification increased in metabolic syndrome patients (56%).

Numerous studies have reported an association between MetS and CAC. **Mahoney et al.** found that there is an increase in coronary calcification in young adults with components of metabolic syndrome such as increased waist circumference, decreased HDL, and increased blood pressure in childhood [20].

The present study found that serum HDL. Cholesterol is strongly correlated with the presence and extent of CAC (P-value 0.02129). Similarly, The Pathobiological Determinants of Atherosclerosis in Youth research group showed that the atherosclerotic lesions in the aorta and right coronary artery were significantly high with low levels of high-density lipoprotein cholesterol in adolescents and young adults between the ages of 15 and 34 [21]. Also, **Bacha et al** found that low HDL cholesterol was consistently one of the most strongly associated risk factors for the presence of coronary artery calcification in young adults [22].

It is noteworthy that total cholesterol and LDL cholesterol were significantly associated with increased coronary calcium score (P-value 0.04). **Lee et al** agreed with the same findings and concluded that there was a positive relationship between LDL cholesterol and the relative risk for incident CAC was attenuated by higher HDL cholesterol levels. Therefore, HDL cholesterol levels should be considered when estimating CVD risk.[23] Also, **Hecht et al.** found that patients who demonstrated the presence of calcified coronary plaque had higher total and LDL cholesterols while having lower HDL cholesterol levels. Consistent with our findings. [24] Additionally, CAC had an ascending trend with increasing age

Our study showed that central obesity identified by increased waist circumference was significantly associated with the presence and extent of coronary calcium (P-value 0.001), whereas BMI was not. Our findings were consistent with the results from the **St Francis Heart Study** [25] The Coronary Artery Risk Development in Young Adults study showed that higher waist circumference and waist to hip ratio were associated with CAC in 2951 white young adults and African-Americans. [26]

Studies were conducted to determine whether BMI or WC are better predictors of atherosclerosis [27] **Lean et al.,** found that BMI was not correlated with, many of the known risk factors for CHD, whereas WC was correlated. [28]

Contrary to previous studies published by **Hoff et al.,** [29]**, Schurgin et al.,** [30], and **Wagenknecht et al.,** [31] we found that the relation between diabetes and CAC is insignificant. Even though diabetes mellitus (DM) represents a strong risk factor for CAD yet its association with CAC is controversial. [32]

Unlike **Thompson et al.,** [33], we found that hypertension has insignificant relation with CAC. **McInnes GT** found a strong and consistent link between hypertension and coronary artery disease, however, this does not mean that hypertension is the cause of coronary artery disease. [34]

An unexpected finding in this study was that serum TG was not correlated with the presence or extent of coronary calcium. The mechanisms of the association between triglycerides and coronary atherosclerosis remain to be clarified by further investigations, in particular those concerning the genetic susceptibility of dyslipidemic subjects[35]. Several observations suggest a familial component in the excessively high levels of serum triglyceride in individuals who would develop early coronary heart disease. [36,37]

Reza et al., Found that metabolic Syndrome was related to the severity of CAD both clinically and by angiographic scores, they had a higher prevalence of ST-elevation myocardial infarction, multi-vessel disease, decreased ejection fraction, and more severe angiographic stenosis based on both modified Gensini and syntax scores, compared to those without metabolic syndrome. [38]

CONCLUSION

Metabolic syndrome is significantly associated with the presence and extent of coronary calcifications and lesions even in asymptomatic patients. When there is an increase in the number of metabolic syndrome components, there is a significant increase in the prevalence of coronary heart diseases.

CAC screening is an accurate and valuable modality as a completely non-invasive and relatively time-efficient screening way when avoid high radiation burden to patients with metabolic syndrome criteria even when asymptomatic.

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REFERENCES

1. **Hadaegh F, Ghasemi A, Padyab M, Tohidi M, Azizi F.** The metabolic syndrome and incident diabetes: Assessment of alternative definitions of the metabolic syndrome in an Iranian urban population. Diabetes Res Clin Pract 2008; 80: 328-334.
2. **Hadaegh F, Zabetian A, Khalili D, Safarkhani M, Philip T James W.** A new approach to compare the predictive power of metabolic syndrome defined by a joint interim statement versus its components for incident cardiovascular disease in Middle East Caucasian residents in Tehran. J Epidemiol Community Health 2012; 66: 427-432.
3. **Guerrero-Romero F and Rodríguez-Morán M** Concordance between the International Diabetes Federation definition for diagnosing metabolic syndrome with the National Cholesterol Education Program Adult Treatment Panel III and the World Health Organization definitions. Diabetes Care 2005; 28: 2588-89.
4. **Anderson PJ, Critchley JAJH, Chan JCN, Cockram CS, Lee ZS, Thomas GN, et al ..** Factor analysis of the metabolic syndrome: obesity vs insulin resistance as the central abnormality. International Journal of Obesity 2001; 25:1782.
5. **Hu G, Qiao Q, Tuomilehto J** For the DECODE Study Group. Prevalence of the metabolic syndrome and its relation to all-cause and cardiovascular mortality in nondiabetic European men and women. Arch Intern Med 2004; 164:1066-76
6. **Sasthi Narayan Chakraborty, Sunetra Kaviraj Roy, Md Abdur Rahaman** Epidemiological predictors of metabolic syndrome in urban West Bengal, India J Family Med Prim Care. 2015; 4(4): 535–538.
7. **Arad Y, Spadaro LA, Goodman K, Newstein D, Guerci AD**. Prediction of coronary events with electron beam computed tomography. J Am Coll Cardiol 2000; 36: 1253-60.
8. **Oudkerk M, Stillman AE, Halliburton SS, Kalender WA, Möhlenkamp S, McCollough CH, et al.** Coronary artery calcium screening: current status and recommendations from the European Society of Cardiac Radiology and North American Society for Cardiovascular Imaging. Int J Cardiovasc Imaging 2008; 24:645–71.
9. **Greenland P, Bonow RO, Brundage BH, Budoff MJ, Eisenberg MJ, Grundy SM, et al.** ACCF/AHA clinical expert consensus document on coronary artery calcium scoring by computed tomography in global cardiovascular risk assessment and evaluation of patients with chest pain: a report of the American College of Cardiology Foundation Clinical Expert Consensus Task Force (ACCF/AHA Writing Committee to Update the 2000 Expert Consensus Document on Electron Beam Computed Tomography). Circulation 2007; 115:402–6.
10. **Agatston AS, Janowitz WR, Hildner FJ, Zusmer NR, Viamonte M Jr, Detrano R..** Quantification of coronary artery calcium using ultrafast computed tomography. J Am Coll Cardiol 1990; 15:827–32.
11. **Callister TQ, Cooil B, Raya SP, Lippolis NJ, Russo DJ, Raggi P.** Coronary artery disease: improved reproducibility of calcium scoring with an electron-beam CT volumetric method. Radiology 1998; 208: 807–14.
12. **Hoffmann U, Siebert U, Bull-Stewart A, Achenbach S, Ferencik M, Moselewski F et al.** Evidence for lower variability of coronary artery

calcium mineral mass measurements by multidetector computed tomography in a community-based cohort—consequences for progression studies. Eur J Radiol 2006; 57:396–402.

13. **Keelan PC, Bielak LF, Ashai K, Jamjoum LS, Denktas AE, Rumberger JA et al.** Long-term prognostic value of coronary calcification detected by electron-beam computed tomography in patients undergoing coronary angiography. Circulation 2001; 104:412–17.
14. **Wong ND, Hsu JC, Detrano RC, Diamond G, Eisenberg H, Gardin JM.** Coronary artery calcium evaluation by electron beam computed tomography and its relation to new cardiovascular events. Am J Cardiol 2000; 86:495–98.
15. **Arad Y, Spadaro LA, Goodman K, Newstein D, Guerci AD.** Prediction of coronary events with electron beam computed tomography. J Am Coll Cardiol 2000; 36:1253–60.
16. **National Cholesterol Education Program,** Adult Treatment Panel III (ATP III) 2001 J Manag Care Pharm. 2003;9(1):2-5.
17. **Moran A, Gu D, Zhao D, Coxson P, Wang YC, Chen CS, et al.** Future cardiovascular disease in China: Markov model and risk factor scenario projections from the coronary heart disease policy Model-China. Circ Cardiovasc Qual Outcomes 2010; 3: 243-52
18. **Coylewright M, Rice K, Budoff MJ, Blumenthal RS, Greenland P, Kronmal R et al.** Differentiation of severe coronary artery calcification in the Multi-Ethnic Study of Atherosclerosis. Atherosclerosis 2011; 219: 616-22.
19. **Ellison RC, Zhang Y, Wagenknecht LE, Eckfeldt JH, Hopkins PN, Pankow JS et al.** Relation of metabolic syndrome to calcified atherosclerotic plaque in coronary arteries and aorta. Am J Cardiol 2005; 95:1180-86.
20. **Mahoney LT, Burns TL, Stanford W, Thompson BH, Witt JD, Rost CA, et al.** Coronary risk factors measured in childhood and young adult life are associated with coronary artery calcification in young adults: the Muscatine Study. J Am Coll Cardiol 1996; 27: 277–84.
21. **PDAY Research Group.** Relationship of atherosclerosis in young men to serum lipoprotein cholesterol concentrations and smoking. A preliminary report from the pathobiological determinants of atherosclerosis in the youth research group. JAMA 1990; 264:3018– 24.
22. **Fida Bacha, Daniel Edmundowicz, Kim Sutton-Tyrell, SoJung Lee, Hala Tfayli, Silva A. Arslanian.** Coronary risk factors measured in childhood and young adult life are associated with coronary artery calcification in young adults: the Muscatine Study. J Am Coll Cardiol 1996; 27:277–84
23. **Lee DY, Kim JH, Park SE, Park CY, Oh KW, Park SW etal .** Effects of Low-density Lipoprotein Cholesterol on Coronary Artery Calcification Progression According to High-density Lipoprotein Cholesterol Levels. Arch Med Res. 2017 Apr;48(3):284-91
24. **Hecht HS, Superko RH, Smith KL, McColgan BP.** Relation of coronary artery calcium identified by electron beam tomography to serum lipoprotein levels and implications for treatment. Prev Cardiol 2001; 87:406– 12.
25. **Lakka HM, Laaksonen DE, Lakka TA, Niskanen LK, Kumpusalo E, Tuomilehto J et al.** The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. JAMA 2002; 288:2709-16.
26. **Yuli Huang, Xiaoyan Cai, Weiyi Mai, Meijun Li, Yunzhao Hu.** Ten-year risk of cardiovascular incidence related to diabetes, prediabetes, and metabolic syndrome. Am Heart J 2007; 153:552-8.
27. **Hunt KJ, Resendez RG, Williams K , Haffner SM, Stern MP.** National Cholesterol Education Program versus World Health Organization metabolic syndrome about all-cause and cardiovascular mortality in the San Antonio Heart Study. Circulation 2004; 110:1251-7.
28. **Lean MEJ, Han TS, and Morrison CE.** Waist circumference as a measure for indicating the need for weight management. Br Med J 1995; 311:158-161.
29. **Hoff JA, Quinn L, Sevrukov A, Lipton RB, Daviglus M, Garside DB et al.** The prevalence of coronary artery calcium among diabetic individuals without known coronary artery disease. J Am Coll Cardiol 2003; 41(6):1008–12.
30. **Schurgin S, Rich S and Mazzone T.** Increased prevalence of significant coronary artery calcification in patients with diabetes. Diabetes Care 2002; 24:335–38.
31. **Wagenknecht LE, Bowden DW, Carr JJ, Langefeld CD, Freedman BI, Rich SS.** Familial aggregation of coronary artery calcium in families with type 2 diabetes. Diabetes 2001; 50:861–66.
32. **Joseph Shemsha, Tenenbaum A, Fisman EZ, Koren-Morag N, Grossman E.**Coronary calcium in patients with and without diabetes: the first manifestation of acute or chronic coronary events is characterized by different calcification patterns Cardiovasc Diabetol. 2013; 12: 161.
33. **Mahoney LT, Thompson BH, Stanford W, Bums TL, Witt JD.** Risk factors measured in childhood and young adult life relate to the development of coronary artery calcification: the Muscatine study. Circulation 1994; 90(suppl I): I-26.
34. **McInnes GT.** Hypertension and coronary artery disease: cause and effect. 1995 Aug;13(2): S49-56**.**
35. **Austin M.** Plasma triglyceride and coronary heart disease. Arteriosclerosis and Thrombosis 1991; 11:2-14.
36. **Benfante RJ, Reed DM, Maclean CJ, Yano K..** Risk factors in middle age that predict early and late onset of coronary heart disease. J Clin Epidemiol 1989; 42:95-104.
37. **Goldstein JL, Schrott HG, Hazzard WR, Bierman EL, Motulsky AG..** Hyperlipidemia in

coronary heart disease: II. Genetic analysis in 176 families and delineation of a new inherited disorder, combined hyperlipidemia. J Clin Invest 1973; 52:1544-68.

38. **Reza Miri, Amir Sajjadieh, Mohammad Parsamahjoob**, **Bahareh Hajibaratali, Masood Shekarchizadeh, Ali Asghar Kolahi et al** Relationship between metabolic syndrome and angiographic severity of coronary artery disease 2016; 12(5): 220–25.

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