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Correlation between Coronary Calcium Score and Lipid Profile

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ABSTRACT

Background: Coronary artery disease (CAD) is a prevalent symptom of cardiovascular disease, which is a major worldwide health problem. Dyslipidemia, characterized by aberrant lipid levels, significantly contributes to CAD development and progression. **Objective:** This study aimed to investigate whether a correlation exists between dyslipidemia, as assessed by lipid profile parameters, and CAC in individuals presenting with chest pain and a low to intermediate PTP for CAD, utilizing multidetector computed tomography (MDCT) imaging.

Methods: An observational cross-sectional study on 100 patients at CT scan Units in El-Mokattam Health Insurance Hospital and Benha University Hospitals. The patients underwent a comprehensive diagnostic work-up including full medical history, clinical examination, blood tests, ECG, and transthoracic echocardiography (TTE) in addition to MDCT for coronary artery calcification (CCS) measurement. **Results:** Ca^{2+} score had a mean value of 466.6 ± 147.9. 38 (38%) patients had Ca^{2+} score % < 400 and 62 (62%) patients had Ca^{2+} score % > 400. A significant positive correlation was found between Ca^{2+} score and age, cholesterol, LDL, and TG (r=0.647, 0.772, 0.717, r=0.651, respectively with P<0.001). There was a significant negative correlation between Ca^{2+} score and HDL (r= -0.826, P<0.001).

Conclusions: There was a significant association between calcium score and age, lipid profile, as well as HTN, smoking, DM, and ischemic heart disease family history. Furthermore, it was found that patients with a Ca^{2+} score > 400 had a higher incidence of hyperlipidemia and were generally older than those with a lower calcium score.

Keywords: Coronary calcium score, Coronary artery disease, Lipid profile, MDCT.

INTRODUCTION

Globally, cardiovascular disease (CVD) continues to be the major cause of morbidity and death, highlighting the need of early detection and care of persons at risk. The formation of atherosclerotic plaques within the coronary arteries characterizes coronary artery disease (CAD), a typical symptom of CVD. Identifying people at elevated risk for CAD is essential for adopting suitable preventative measures [1].

Long known as key factors to the onset and progression of atherosclerosis, lipid abnormalities, including dyslipidemia, are particularly implicated. CAD risk factors include elevated levels of low-density lipoprotein cholesterol and reduced levels of high-density lipoprotein cholesterol. Despite the documented relationship between lipid profile and CAD, the measurement of lipid parameters alone may not give a thorough evaluation of an individual's risk [2].

Recent advances in imaging technology have enabled a unique approach to risk stratification in individuals suspected of having CAD. One such method is MDCT, which permits the measurement of coronary artery calcification, sometimes known as the CCS [2]. Coronary calcium scoring has evolved as a non-invasive method for assessing atherosclerotic load and predicting future cardiovascular events. It showed a significant association with the existence and severity of CAD [3].

In the setting of individuals presenting with chest discomfort and a low to moderate pretest probability (PTP) for CAD, evaluating the link between dyslipidemia and coronary calcium score becomes very important. Identifying the relationship between these two variables might improve risk classification and facilitate therapeutic decision-making for this patient population [3, 4]. Therefore, this study aimed to investigate whether a correlation exists between dyslipidemia, as assessed by lipid profile parameters, and CCS in individuals presenting with chest pain and a low to intermediate PTP for CAD, utilizing MDCT imaging.

PATIENTS AND METHODS

Study Design and Participants: This observational cross-sectional study included a total of 100 patients suspected of having coronary artery disease who were presented at the Cardiology Department, Benha University Hospital between May 2022 and January 2023.

Inclusion criteria: Age ≥18 years, both sexes, patients who underwent CT, and a one-month washout period from antihyperlipidemic drugs.

Exclusion criteria: Patients with hypertrophic cardiomyopathy, greater than mild mitral and/or aortic valve disease, sustained tachy-/brady-arrhythmia (including atrial fibrillation) or frequent ectopic beats and reduced left ventricular ejection fraction defined as EF ≤ 50%.

Data Collection:

All participants underwent a comprehensive assessment, including detailed history taking and a full clinical examination. Personal information, such as name, age, gender, body weight, height, and BMI, was recorded. CV risk factors such as diabetes mellitus, hypertension, smoking history, and symptoms suggestive of cardiac disease were documented. HTN was characterized as having a SBP equal to or greater than 140 mmHg and/or a DBP equal to or greater than 90 mmHg, and/or taking medication specifically designed to treat high blood pressure. Diabetes mellitus was determined based on symptoms and specific plasma

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glucose concentrations or the use of glucose-lowering medications. Smoking history included both current and former smokers. Dyslipidemia was defined as specific lipid profile parameters exceeding certain thresholds or the use of lipid-lowering drugs. Obesity was determined based on BMI ≥ 30 kg/m².

Additional assessments included a general examination of vital signs (pulse, blood pressure, respiratory rate, and temperature) and a systemic examination with a focus on the cardiovascular system to detect any abnormal heart sounds or murmurs. Routine laboratory investigations were conducted, including complete blood count, kidney function tests (Creatinine and urea), random blood sugar, and liver function tests (AST, ALT). ECG in the form of a twelve-lead surface ECG was performed for all patients.

Imaging Techniques:

Transthoracic echocardiography (TTE) was conducted using commercially available machines, acquiring 2D, M-mode, and Doppler images. The examination was performed with the patient in a supine or left lateral position, following EACVI guidelines, and images were obtained in the left parasternal long axis (LAX) view, apical 4, 3, and 2-chamber views.

Multi-slice CT was performed using a Multislice Aquilion 320 system. Patients without contraindications received premedication with an oral beta-blocker. If the heart rate was ≥70 beats/min, additional oral ivabradine was administered if tolerated. Prior to the procedure, patients were instructed not to eat for 3-4 hours and to abstain from caffeine products for 12 hours. Regular medications, especially blood pressure medications, were taken as prescribed on the day of the examination. Metformin use was discontinued for at least 48 hours after contrast administration. The coronary artery calcium (CAC) scores were reported as average CAC Agatston scores, calculated by summing the calcification in all coronaries as well as separately in each vessel (left circumflex, left anterior descending, and right coronary artery). The assessment relied on the size and concentration of calcification, considering two adjacent pixels with an attenuation coefficient greater than 130 Hounsfield units as indicative of calcium deposits. Four knowledgeable observers, unaware of the clinical information, examined the images.

Ethical consideration: This study received ethical approval from the Institutional Review Board, Faculty of Medicine, Benha University. All participants provided written informed consents. The study adhered to the ethical guidelines outlined in the World Medical Association's Declaration of Helsinki for research involving human subjects.

Statistical analysis

Statistical analysis was done by SPSS version 26 for statistical analysis (IBM Inc., Chicago, IL, USA). Using an unpaired Student's t-test to compare the two groups, mean and standard deviation (SD) values were supplied. Appropriate, qualitative variables were expressed as frequency and (%) and examined with the Chi-square or Fisher's exact test. Pearson correlation was used to quantify the degree of relationship between two quantitative variables. A two tailed P-value equal to or less than 0.05 was considered statistically significant.

RESULTS

This single center, cross sectional study was performed on 100 individuals at CT scan unit at El-Mokattam Health Insurance Hospital and Benha University Hospitals.

Regarding the baseline characteristic data of the studied individuals, age extended from 30-75 years with 56.24 ± 13.24 years as a mean. There were 59 (59%) males and 41 (41%) females. Weight ranged from 60-95 Kg with a mean of 76.9 4 ± 10.68 Kg. Height ranged from 1.5 - 1.8 m with a mean of 1.65 ± 0.09 m. BMI ranged from 18.52 - 39.54 Kg/m^2 with a mean of 28.46 ± 4.86 Kg/m^2. Among the studied patients, 40 (40%) patients were hypertensive, 36 (36%) patients were diabetics, 34 (34%) patients were smokers and 36 (36%) patients had family history of ischemic heart disease. Regarding the vital signs among the studied individuals, SBP ranged between 110 -140 mmHg with a mean of 126.0 ± 10.15 mmHg. DBP ranged from 70 – 90 mmHg with 79.9 ± 7.18 mmHg as a mean. RR ranged from 18 – 25 breath/min with a mean of 21.72 ± 2.37 breath/min. O_2 saturation ranged from 97 – 99 % with a mean of 98.07 ± 0.83 % (Table 1).

Table 1: Baseline Characteristic data, Comorbidities and Vital signs of the studied patients

		N=100
Age (years)	**Mean ± SD**	56.24 ± 13.24
	Range	30 - 75
Sex	**Male**	59 (59%)
	Female	41 (41%)
Weight (Kg)	**Mean ± SD**	76.9 4 ± 10.68
	Range	60 - 95
Height (m)	**Mean ± SD**	1.65 ± 0.09
	Range	1.5 - 1.8
BMI (Kg/m^2)	**Mean ± SD**	28.46 ± 4.86
	Range	18.52 - 39.54
Comorbidities		
HTN		40 (40%)
DM		36 (36%)
Smoking		34 (34%)
Family history of ischemic heart disease		36 (36%)
Vital signs		
SBP (mmHg)	**Mean ± SD**	126.0 ± 10.15
	Range	110 -140
DBP (mmHg)	**Mean ± SD**	79.9 ± 7.18
	Range	70 - 90
RR (breath/min)	**Mean ± SD**	21.72 ± 2.37
	Range	18 - 25
O_2 saturation (%)	**Mean ± SD**	98.07 ± 0.83
	Range	97 - 99

HTN: hypertension, BMI: body mass index, DM: diabetes mellitus, DBP: diastolic blood pressure, SBP: systolic blood pressure, RR: Respiratory rate

Hb ranged from 9 – 13 gm/dL with a mean of 10.87 ± 1.17 gm/dL. WBC ranged from 4.5 - 11 *10^3cells/ml with a mean of 7.74 ± 1.96 *10^3cells/ml. PLT ranged from 156 – 400 *10^3cells/ml with a mean of 277.41 ± 69.29 *10^3cells/ml. FBS ranged from 70 – 99 mg/dL with a mean of 85.18 ± 8.89 mg/dL Urea ranged from 8 – 20 mmol/L with a mean of 13.69 ± 3.7 mmol/L. Creatinine ranged from 0.7 - 0.99 mg/dL with a mean of 0.84 ± 0.09 mg/dL (Figure 1).

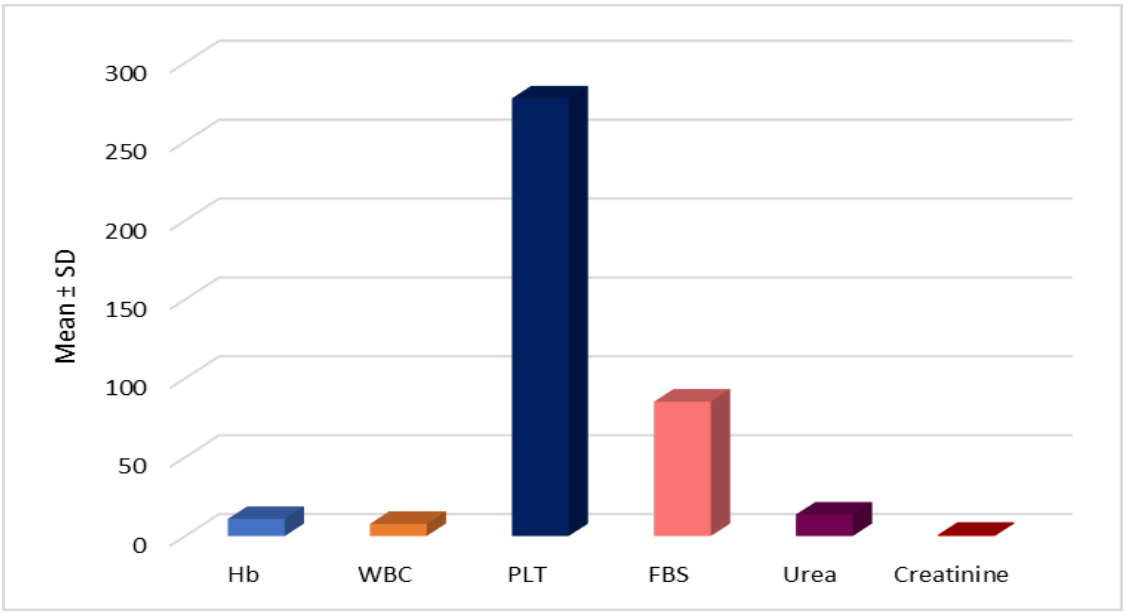

Figure 1: Laboratory investigation of the studied patients

ALT ranged from 8 – 54 U/L with a mean of 32.21 ± 13.68 U/L. AST ranged from 8 – 33 U/L with a mean of 20.76 ± 7.25 U/L. Cholesterol had a mean value of 234.53 ± 57.63 mg/dL with a range of 135 – 347 mg/dL. HDL had a mean value of 46.5 ± 20.96 mg/dL with a range of 26 – 90 mg/dL. LDL had a mean value of 139.22 ± 48.37 mg/dL with a range of 81 – 228 mg/dL. TG ranged from 90-400 mg/dL with a mean of 236.03 ± 84.3 mg/dL (Figure 2).

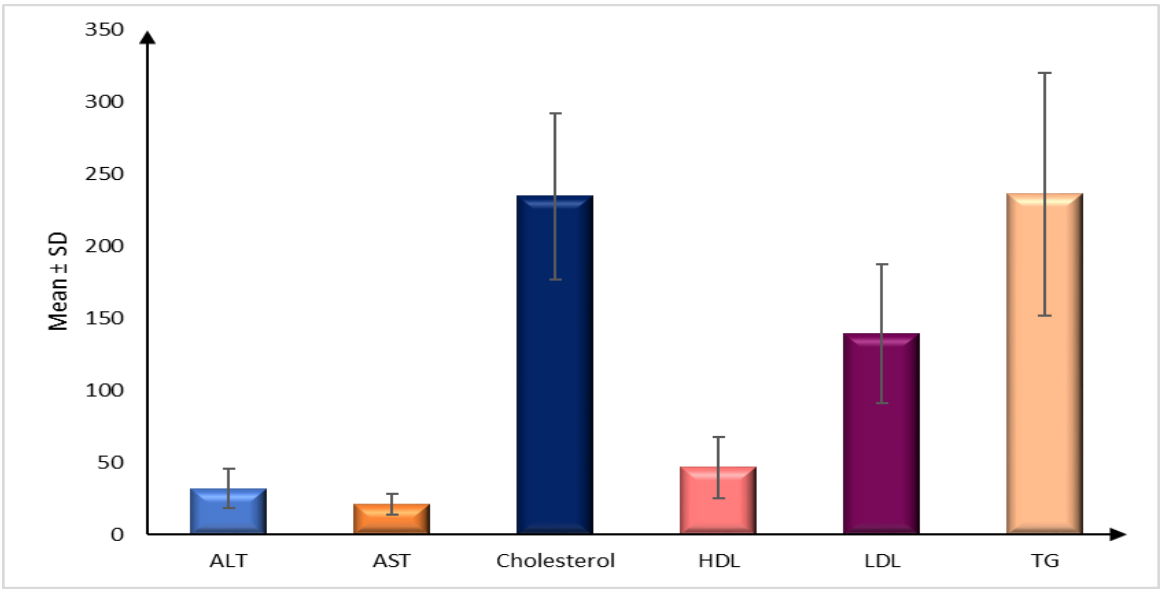

Figure 2: Lipid profile of the studied patients.

Ca score of the studied cases extended between 200-697 with 466.6 ± 147.9 as a mean. 38 (38%) patients had Ca score % <400 and 62 (62%) patients had Ca score % >400 (Table 2).

Table 2: Ca score of the studied patients

		N=100
Ca score	**Mean ± SD**	466.6 ± 147.9
	Range	200-697
Ca score %	**< 400**	38 (38%)
	> 400	62 (62%)

Ca: calcium.

Age and Ca score were substantially greater in individuals with Ca score > 400 in comparison with those with Ca score < 400 (P value < 0.001). Regarding the lipid profile, cholesterol, LDL and TG were significantly greater in cases with Ca score > 400 in comparison with those with Ca score < 400. While HDL was considerably lower in cases with Ca score > 400 compared to those with Ca score < 400 (P value <0.001) (**Table 3**).

Table 3: Comparison between Calcium score according to baseline data, Ca and lipid profile

	Calcium score < 400 (n=38)	Calcium score > 400 (n=62)	P value
Age (year)	43.1 ± 9.3	64.3 ± 7.6	**<0.001***
Ca score	299.5 ± 65.0	569.1 ± 69.7	**<0.001***
Cholesterol (mg/dL)	177.0 ± 14.8	269.8 ± 43.9	**<0.001***
HDL (mg/dL)	70.6 ± 13.8	31.7 ± 3.9	**<0.001***
LDL (mg/dL)	89.9 ± 6.04	169.4 ± 36.6	**<0.001***
TG (mg/dL)	154.6 ± 26.5	285.9 ± 54.1	**<0.001***

Data presented as mean ± SD, Ca: calcium, LDL: low density lipoprotein, HDL, high density lipoprotein TG: triglycerides, *: statistically significant as P value <0.001

There was a significant positive correlation between Ca score and age, cholesterol, LDL, and TG (r=0.647, 0.772, 0.717, r=0.651, respectively with P<0.001). There was a significant negative correlation between Ca score and HDL (r= -0.826, P<0.001).

There was an insignificant correlation between Ca score and other parameters (Family history, DM and HTN) (Table 4).

Table 4: Correlation between Calcium score and different parameters

	Ca score	
	r	**p**
Age (year)	0.647	**<0.001***
Family history	-0.103	0.307
DM	-0.004	0.972
HTN	-0.022	0.830
Cholesterol (mg/dL)	0.772	**<0.001***
HDL (mg/dL)	-0.826	**<0.001***
LDL (mg/dL)	0.717	**<0.001***
TG (mg/dL)	0.651	**<0.001***

Ca: calcium, HDL: high density lipoprotein, DM: diabetes mellitus, HTN: hypertension, LDL, low density lipoprotein, TG: triglycerides, r: coefficient correlation, *: statistically significant as P-value <0.001.

DISCUSSION

In terms of baseline and characteristic data of the studied patients, several studies have investigated the baseline characteristics of individuals with established or suspected CAD and reported similar findings to our study. For instance, a study done by **Amin *et al.*** [(5)] on 4,286 individuals undergoing coronary angiography showed that the individuals mean age was 64.3 years, with 71% being male and 29% being female. The mean BMI was 30.4 kg/m^2, and the most common comorbidities were hypertension (72%), dyslipidemia (67%), and diabetes mellitus (38%).

The vital signs and laboratory values reported in this study are consistent with those found in previous studies. In a study by **Singh *et al*.** [(6)] that evaluated the clinical profile of patients with hypertension, the mean SBP and DBP were 138.8 ± 19.4 mmHg and 90.4 ± 11.4 mmHg, respectively, which were higher than the values reported in this study. However, the individuals average age in the Singh study was higher (61.6 ± 11.9 years) than in the current study, which may account for the difference in blood pressure values. In the same line, a study by **Mahmood *et al.*** [7] that examined clinical characteristics of type 2 diabetes individuals, the mean FBS was 165.68 ± 54.05 mg/dL, which was higher than the value found in this study. However, Mahmood study included patients with uncontrolled diabetes, which may explain the higher FBS value.

Regarding laboratory values, the mean Hb, WBC, and PLT values in this study are parallel to those revealed in a study by **Jang *et al.*** [8] that evaluated laboratory parameters in healthy Korean adults. The mean cholesterol, HDL, LDL, and TG values in this study are also consistent with those revealed in a research by **Tauseef *et al.*** [9] which examined the lipid profiles of Pakistani adults.

Regarding Ca score in the current work, several research have investigated the association among age and CA calcium score. One study involving 446 asymptomatic patients found that age was substantially related to an elevated CA calcium score (p<0.001) [10]. Another study, involving 1,025 patients, also reported a

positive correlation between calcium score and age (P-value <0.001) [11]. These findings are in line with the results of the present study. In addition, several studies reported that high Ca calcium scores perveance in various patient populations. A study involving 2,137 asymptomatic patients found that 32% of individuals had a Ca score > 400 [12].

Regarding lipid profile, several studies have investigated the association among ween lipid profile and CA calcium score. For instance, a study by **D'Agostino *et al.*** [13] found that a positive association was seen among total cholesterol, LDL cholesterol, and triglycerides levels with Ca calcium score. Similarly, a research by **Park *et al.*** showed that elevated LDL and decreased HDL cholesterol concentrations were related to an elevated risk of calcium progression in asymptomatic individuals [14]. One study by **Abd Alamir *et al.*** [15] revealed that greater LDL concentrations and lower HDL concentrations were substantially related to an increased calcium score in a multiethnic population. Similarly, a study by **Chung *et al.*** [16] discovered that greater LDL concentrations and triglycerides were independently related to a greater Ca score in a Korean population. Another research by **Agarwala *et al.*** [17] revealed that lower HDL concentrations were significantly related to a higher coronary artery calcium score in a South Asian population. Furthermore, a study by **Kim *et al.*** [18] discovered that greater concentrations of triglycerides were significantly related to a higher coronary artery calcium score.

Several studies have also reported similar findings regarding the significant positive correlation between Ca score and age, as well as the lipid profile parameters such as cholesterol, LDL, and TG, and the substantial negative association among Ca score and HDL as in the current work.

For instance, a study by **Rumberger *et al.*** [19] reported a positive correlation between Ca score and age, cholesterol, LDL, and TG (r=0.45, 0.24, 0.28, and 0.15, respectively with P-value <0.0001), and a negative correlation with HDL (r= -0.20, P<0.0001) in a sample of asymptomatic individuals. Similarly, a research by **Kondos *et al.*** [20] revealed a significant association among Ca score and age, total cholesterol, LDL, and TG (r=0.62, 0.45, 0.39, and 0.32, respectively with P-value<0.001), and a negative correlation with HDL (r= -0.31, P-value <0.001) in a sample of patients with suspected or known coronary artery disease [20].

Finally, this research is limited by its single-center design and very small sample size, that may restrict the generalizability of the findings to broader populations or different clinical settings. Furthermore, the lack of follow-up data prevents the assessment of long-term outcomes in the patients. Additionally, the study did not evaluate the influence of lifestyle factors, such as diet and physical activity, on the Ca score and overall CVD risk.

CONCLUSION

According to the findings of this research, there was a substantial association between calcium score and age, lipid profile (cholesterol, LDL, HDL, and TG), HTN, DM, smoking, and family history of ischemic heart disease. Furthermore, it was observed that patients with a Ca score > 400 had a higher incidence of hyperlipidemia and were generally older than those with a lower calcium score. Ca scoring can be a useful tool for identifying individuals at high risk for developing cardiovascular disease, and that interventions targeting these risk factors could potentially prevent or delay the onset of cardiovascular disease.

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