Relation between Cardiovascular Disease Risk Factors and Epicardial Adipose Tissue Density on Cardiac Computed Tomography to Coronary Artery Disease in Patients at High Risk of Cardiovascular Events

Abstract

As it permits both vessel luminal evaluation and plaque identification, multi-detector CT angiography has assumed a prominent position in early diagnosis of coronary artery disease (CAD). The purpose of this research was to evaluate the association between epicardial adipose tissue density and coronary artery disease prevalence and location. In accordance with the atherosclerotic cardiovascular disease (ASCVD) recommendations of the American Heart Association and the American College of Cardiology (AHA/ACC), a cross-sectional research was conducted on 50 individuals at high risk of CAD. Patients had a thorough history and physical examination as well as laboratory tests (serum creatinine, estimated glomerular filtration rate, and MDCT angiography). There were statistically significant differences between the two groups in proximal LCX, distal LAD, and distal LCX. Proximal RCA, proximal LCX, middle LCX, distal RCA, and distal LAD all differed significantly by severity group. Both the proximal LCX (r= 0.286, P=0.044) and the distal LAD (r= 0.554, P0.001) were positively correlated with Severity of Coronary Artery, whereas the intermediate LAD (r= -0.322, P=0.022) was negatively correlated with Severity of Coronary Artery. In conclusion, the present research found that peri-coronary epicardial fat density is substantially related to the existence and severity of coronary artery disease. Significant positive correlations were found between Severity of Coronary Artery and both the proximal LCX and the distal LAD, whereas substantial negative correlations were found between Severity of Coronary Artery and the intermediate LAD.

Epicardial adipose tissue density; cardiac computed tomography; coronary artery disease; cardiomyopathy; coronary artery disease.

Introduction

The decrease of blood flow to the heart muscles caused by plaque formation in the coronary arteries is the hallmark of coronary artery disease (CAD). The greatest cause of mortality and the most prevalent form of cardiovascular disease globally (1).

Epicardial adipose tissue (EAT) thickness and density are associated with microvascular and coronary artery disease, according to the available evidence (2).

Active adipokines released either paracrinely (via local release and diffusion) or endocrinely (through the systemic circulation) from adipose tissue are known to alter cardiovascular function (3).

Leptin produced from peri-coronary EAT promotes endothelial dysfunction, and greater EAT thickness is linked to higher risk of coronary atherosclerosis development and plaque susceptibility (4).

Located between the visceral pericardium and the myocardium, epicardial fat is real visceral fat that receives its blood supply from the myocardium itself. Furthermore, paracrine effects might be seen. Here we have the metabolically active, unhealthy fat (5).

Due to its ability to perform both luminal assessment of the vessels and plaque identification, multi-detector CT angiography has emerged as a frontrunner in CAD early diagnosis. Research suggests that in addition to clinical risk stratification, plaque detection by cardiac CT may contain predictive information (6).

Tissue densities in CT scans are measured in a measurement system called Hounsfield Units (HU), with fat commonly falling between 190 and 30 HU (7).

Variations in attenuation within this range are thought to be linked to variations in adipose tissue composition. Increased vascularity and decreased lipid content have both been linked to greater attenuation in adipose tissue (higher HU values). Epicardial fat depots that include beige adipose tissue, commonly known as brite (or brown-in-white adipocytes), have been linked to greater attenuation. The presence of adipocyte hypertrophy and increased lipid density in low-HU adipose tissue is indicative of an unfavourable metabolic state linked with systemic low-grade inflammation. Increased calcification of the coronary and extra-cranial carotid arteries is linked to an enlarged epicardial adipose tissue depot (8).

Since epicardial adipose tissue is in such close proximity to the coronary arteries, variations in epicardial adipose tissue composition may have a role in the development of coronary artery calcium (CAC) that is unrelated to epicardial adipose tissue volume. CAC may be more common in patients at high risk for or with apparent cardiovascular disease due to an increase in defective epicardial adipose tissue (9).

The focus of this research was to determine whether and how epicardial adipose tissue density was associated with the existence and location of coronary artery disease.

Cases and Procedures

Fifty patients with atherosclerotic cardiovascular disease (ASCVD) risk factors according to the American Heart Association/American College of Cardiology (AHA/ACC) recommendations were included in this cross-sectional research. Between January 2022 and January 2023, researchers at Benha University Hospitalts analysed data from a sample of adults who had signed an informed consent form and been accepted for participation in the study by the Research ethics committee of the university's School of Medicine.

Patients with an atherosclerotic cardiovascular disease (ASCVD) risk category of "very high" or "high" were included (10). Risk factors for cardiovascular disease include age-related family history of CVD, diabetes mellitus, high blood pressure, smoking, obesity, and chronic renal disease.

Patients with established cardiac or cerebrovascular disease, chest pain, age 80 years or 18 years, pregnancy, significant medical comorbidity, or prior coronary calcium scanning were excluded, as were those with known renal failure (estimated glomerular filtration rate

60 ml/min/1.73 m2) or contra-indications for CT-scanning, such as an allergic reaction to contrast, Irregular heart rate., low ejection fraction, patient with pacemakers

Patients had a thorough history and physical examination as well as laboratory tests (serum creatinine, estimated glomerular filtration rate, and MDCT angiography).

Multi-Degree Computed Tomography Angiography

Evaluation of the Fat Content of the Epicardium: All CT scans were acquired using a 128-slice, multi-detector row device that was ECG-gated (GE Healthcare 3000N. GrandviewBlvd. waukesha. WI53188 U.S.A). Slice collimation was 256 - 0.625 mm, gantry rotation time was 270 ms, tube voltage was 80 - 120 kVp, and the mAs value was automatically selected depending on the patient's weight. For this study, we administered a bolus of iodine contrast agent (Ultravist, Bayer Healthcare, Berlin, Germany; 370mg/l) into the patient's veins at a volume between 70 and 90 ml, based on body weight, and started taking pictures in the middle of the diastolic phase, at 78% of the RR interval. Characteristics of the patients were hidden from the observer.

The fatty tissue located between the outer wall of the myocardium and the visceral layer of the pericardium is called the epicardial adipose tissue depot. The carina was chosen as the cranial slice limit and the final slice containing cardiac tissue was chosen as the caudal slice boundary. The pericardium was painstakingly traced using specialised volumetric software at 1cm intervals inside this region (GE revolution AW workstation 4.7 2014, GE Healthcare).

The pericardium was converted into a 3D area of interest in a semi-automatic manner by the programme. Epicardial adipose tissue attenuation (in HU) and volume (in cm3) were calculated inside this pericardial-specified area of interest. Adipose tissue was defined as continuous voxels within limits of -190 and -30 HU. Excellent inter- and intra-observer correlations ($r = 0.97$ and $r = 0.93$) have been recorded for this approach, demonstrating its reliability (10).

calcium score evaluation: Agatston coronary calcium score (CCS) was calculated as the sum of calcified plaque scores of all coronary arteries using semi-automatic commercially available calcium scoring software (CCS was reported in three categories: no coronary calcium (CCS of 0), early atherosclerosis (CCS 1-99), and more advanced atherosclerosis (CCS 100). (11).

Coronary stenosis evaluation: Coronary segments were recognised by an outside observer using a modified American Heart Association categorization. In terms of stenosis severity, segments were categorised as either normal (having smooth parallel boundaries), mild (luminal stenosis 50%), or severe (luminal stenosis 50%). (12).

Contrast material allergy is a potential adverse consequence.

Number crunching

IBM's statistical programme, SPSS, version 20.0, was used to examine the data provided into the computer. I.B.M. Corporation, Armonk, New York (2) Quantitative and percentage descriptions were used for qualitative information. To ensure a normally distributed sample, we employed the Kolmogorov-Smirnov test. The lowest and maximum values, as well as the mean and standard deviation, were used to characterise the quantitative data. Chi-square tests were employed to compare groups based on categorical data. Use the Student t-test to compare two groups using a quantitative variable. Comparing two groups using the Mann-Whitney U test for anomalous quantitative variables. The acquired findings were deemed significant at the 5% level.

Results

Average age was 53.28 5.668 years (range: 44 - 66). 44 (88.0%) had hypertension, 25 (50.0%) had diabetes, 2 (4.0%) had a history of coronary artery bypass grafting, and 4 (8.0%) had a history of stents. Out of the total sample size of 64 participants, 32 (64.0%) did not smoke, 16 (32.0%) smoked regularly, and 2 (4.0%) had ever smoked. Table 1

The proximal RCA values were as follows: (-127, -77)(-107, -11,659). Average proximal LAD was -109.516.331, with a range of -166 to -88. The proximal LCX values were as follows: (-128, -54) (-93,54, -15,69). The median RCA was -101.9417.308, with a range of -129 to -64. The median middle LAD was -105.0420.165, with a range of -160.04 to -74.0. The median LCX was -106.84-14.538, with a range of -140 to -77. The distal RCA values were on a scale from -125 to -53, with a mean of -99.82 and a standard deviation of 17.82. The distal LAD values varied from -125 to -37, with a mean of -93.18 22.64 8. The distal LCX values were on average -103.4813.377 and varied from -145 to -84. Table 2 shows that among the sample, 10% had normal coronary arteries, 36% had mild coronary arteries, 28% had intermediate arteries, and 16% had severe coronary arteries. Table 3

Proximal LCX, distal LAD, and distal LCX all differed significantly between the two groups statistically. According to Table 4, there were statistically significant differences in proximal RCA, proximal LCX, middle LCX, distal RCA, and distal LAD across severity groups. Table 5 shows that the severity of the coronary artery disease was positively correlated with the proximal LCX (r= 0.286, P=0.044) and the distal LAD (r= 0.554, P0.001) but negatively correlated with the intermediate LAD (r= -0.322, P=0.022). Comment of Table 6

Epicardial adipose tissue (EAT) has been shown to be a key player in the pathogenesis of CAD (13).

The average age of the sample was found to be 53.285.668 years, with hypertension (HTN) (88%) and diabetes (50%) being the most frequent comorbidities. Out of the total sample size of 64 participants, 32 (64.0%) did not smoke, 16 (32.0%) smoked regularly, and 2 (4.0%) had ever smoked.

Smoking, high blood pressure, diabetes, and a family history of coronary artery disease were the most common conventional cardiovascular risk factors among the 950 individuals studied (51.1 11.23 years old). Age, male gender, and the existence of established cardiovascular risk factors were also shown to be linked with CAD (14).

Ten (20%) of the participants were considered to be within the normal range, eighteen (36.0%) to be light, fourteen (28.0%) to be moderate, and ten (20%) to be severe.

Tissue densities in CT scans are measured in a system called Hounsfield units (HU), with the radiodensity of fat commonly falling between an attenuation range of -190 to -30 HU (15).

Increases in EAT attenuation are linked to an increased risk of CAD. Patients with a history of CABG surgery and severe coronary artery disease showed greater attenuation of EAT, which is consistent with a study showing greater attenuation of EAT in patients with at least one coronary artery stenosis compared to attenuation of EAT of patients without coronary artery disease. These results provide credence to the theory that the persistent inflammation seen in cardiovascular disease may lead to the fibrosis and attenuation of adipose tissue (16).

A research with 120 participants bolstered this finding; of those tested, just 22 did not have CAD, while the remaining 98 did (17). Epicardial fat volume > 124 cm3 is chosen as appropriate cut off value (sensitivity 78.57%, Specificity 72.73%) to identify positive CTA patients (p= 0.001). The research found that there was a statistically significant difference between the two groups in this respect (p 0.001). In patients with ostial and ostio-proximal LA lesions, mid-segment LAD lesions, and mid-segment LCx lesions, the mean value of the cumulative number of the epicardial fat volume was considerably greater.

Moreover, in a study (18). Fifty-three individuals having coronary angiograms had their epicardial fat thickness (EFT) assessed. The CAD group had a considerably greater mean EFT than the control group did (3.25 1.15 mm vs 5.55 1.21 mm, p 0.0001). An EFT cut-off of 4.75 mm predicted clinically relevant CAD with 87.5% sensitivity and 63.5% specificity (AUC: 0.831, p 0.001).

Patients with substantial coronary artery stenosis had considerably larger EFV than those without significant CAD, as was revealed in the research (19) employing automated volumetry of epicardial fat by MSCT.

In addition, our findings were consistent with those of a recently published systematic review and meta-analysis (20), which evaluated the relationship between EAT and CAD. This meta-analysis included 21 studies with a total of 4975 subjects; 2377 had been diagnosed with CAD and were placed in one group, while the other 2598 were placed in the other group. Both the volume and thickness of EAT were found to be significantly higher in the CAD group compared to the non-CAD group in the pooled analysis (p 0.00001).

While looking at the correlation between Coronary Artery Disease Severity and epicardial fat measured in Hounsfield units, it was shown that there were statistically significant variations across severity groups when dividing by proximal RCA, proximal LCX, middle LCX, distal RCA, and distal LAD.

This is consistent with the findings of a research showing that individuals with more severe coronary artery stenosis had a greater amount of epicardial fat (14).

Epicardial fat thickness (EFT) was shown to correspond with the Gensini score for coronary artery disease (CAD) severity (r = 0.906, p 0.001). (18).

Conclusion

The present research concluded that the density of fat tissue in the epicardial peri-coronary region is strongly related to the existence and severity of coronary artery disease. Significant positive correlations were found between Severity of Coronary Artery and both the proximal LCX and the distal LAD, whereas substantial negative correlations were found between Severity of Coronary Artery and the intermediate LAD.

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Author's Role

Both authors had equal input on the research.

Interest discrepancies

There are no competing interests.

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Table 1: Distribution of studied sample according to demographic data

	Number	Percent
Age (years)		
Range	44–66	
Mean ± S.D.	53.28±5.668	
Comorbidity		
HTN	44	88.0
DM	25	50.0
CABG	2	4.0
Stent	4	8.0
Smoking		
Non-Smoker	32	64.0
Current Smoker	16	32.0
Ex-Smoker	2	4.0

Table 2: Distribution of studied sample according to house field unit of epicardial fat

	Range	Mean ± S.D.
Proximal		
RCA	-127 – -77	-107.46±11.659
LAD	-166 – -88	-109.5±16.331
LCX	-128 – -54	-93.54±15.69
Middle		
RCA	-129 – -64	-101.94±17.308
LAD	-160 – -74	-105.04±20.165
LCX	-140 – -77	-106.84±14.538
Distal		
RCA	-125 – -53	-99.82±17.82
LAD	-125 – -37	-93.18±22.648
LCX	-145 – -84	-103.48±13.377

Table 3: Distribution of studied sample according to Severity of Coronary Artery

Severity of Coronary Artery	Number	Percent
Normal	10	20.0
Mild	18	36.0
Moderate	14	28.0
Severe	8	16.0
Total	50	100

Table 4: Comparison between normal and severity patients according to house field unit of epicardial fat

	Severity of Coronary Artery		Test of Sig.	P value
	Normal patients	Severity patients		
Proximal				
RCA	-109.1±11.742	-104.11±12.746	U= 164.00	0.395
LAD	-104.5±6.835	-105.78±15.176	U= 142.00	0.166
LCX	-104.9±13.699	-94.78±11.322	t = 2.722	0.009*
Middle				
RCA	-103.9±16.536	-104.33±16.161	U= 198.00	0.971
LAD	-102.4±14.222	-98.67±11.008	U= 194.00	0.896
LCX	-99±14.614	-117.78±12.105	U= 125.00	0.070
Distal				
RCA	-96.5±14.222	-97.56±14.284	t = 0.655	0.516
LAD	-114.3±12.01	-97.89±13.655	t = 3.699	0.001*
LCX	-107.6±5.562	-99.67±11.262	U= 118.0	0.047*

Table 5: Relation between Severity of Coronary Artery and house field unit of epicardial fat

	Severity of Coronary Artery				
	Normal	**Mild**	**Moderate**	**Severe**	**P value**
Proximal					
RCA	-109.1±11.742	-104.11±12.746	-115.57±5.515	-98.75±8.498	0.001*
LAD	-104.5±6.835	-105.78±15.176	-116.71±22.241	-111.5±12.201	0.161
LCX	-104.9±13.699	-94.78±11.322	-81.57±14.643	-97.5±16.725	0.001*
Middle					
RCA	-103.9±16.536	-104.33±16.161	-101.86±21.764	-94.25±11.985	0.392
LAD	-102.4±14.222	-98.67±11.008	-104.57±26.786	-123.5±21.334	0.083
LCX	-99±14.614	-117.78±12.105	-103.14±8.347	-98.5±14.745	<0.001*
Distal					
RCA	-96.5±14.222	-97.56±14.284	-114.29±7.878	-83.75±24.685	<0.001*
LAD	-114.3±12.01	-97.89±13.655	-79.29±28.57	-80.5±13.126	<0.001*
LCX	-107.6±5.562	-99.67±11.262	-100.29±11.418	-112.5±22.084	0.118

Table 6: Correlation between Severity of Coronary Artery and house field unit of epicardial fat

	Severity of Coronary Artery	
	r	**P value**
Proximal		
RCA	0.075	0.606
LAD	-0.231	0.106
LCX	0.286	0.044*
Middle		
RCA	0.171	0.234
LAD	-0.322	0.022*
LCX	0.151	0.294
Distal		
RCA	0.025	0.864
LAD	0.554	<0.001*
LCX	-0.090	0.534