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Does Echocardiographic Epicardial Fat Thickness Associate with The Severity of Coronary Artery Disease?

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ABSTRACT

Background: One of the main health issues in the world is coronary artery disease (CAD). It frequently causes morbidity and death. From 28.9% in the 1990s to a predicted 36.3% in the 2020s, the global death rate for CAD is anticipated to increase. **Objective:** The aim of the current study was to confirm the relationship between the epicardial adipose tissue thickness on echocardiography and CAD severity. **Patients and Methods:** Epicardial adipose tissue thickness (EATT) was measured by echo in 200 patients referred for coronary angio in Ain Shams University between May 2013and October 2014. **Results:** In our study, diabetic, hypertensive and smoker patients had more significant EATT when compared to non-diabetic, non-hypertensive and non-smoker ones. EATT measured during both systole and diastole was found to be significant in patients with BMI ≥30 and abnormal waist hip ratio when compared to corresponding values of normal BMI and waist hip ratio. On measuring EATT during both systole and diastole, it was found that P-value was significant in high levels of LDL and TGs patients compared to corresponding values in normal levels of LDL and TGs subjects. EATT was highly significant in patients with coronary affection with mean EATT(s) in CAD patients was 6.07 (SD 1.16) compared to 4.22 (SD 0.9) in patients with normal coronaries and mean EATT(d) in CAD patients was 5.77 (SD 1.13) compared to 4.02 (SD 0.9) in patients with normal coronaries. Also, there was a significant correlation between measurements of both systolic and diastolic EATT and the number of diseased coronary artery in CAD patients. Our study showed no significant correlation between gender and EATT measurements during both systole and diastole. **Conclusion:** A significant correlation exists between EAT and the existence and severity of CAD. It supports the idea that epicardial fat may contribute to the development of CAD, presumably through paracrine or vasocrine pathways. EAT may be evaluated safely and non-invasively by echocardiography, as it may be a component of the normal evaluation of individuals suspected of being at risk for cardiovascular or metabolic disorders.

Keywords: Coronary artery disease, Echocardiographic Epicardial Fat Thickness.

INTRODUCTION

Cardiovascular diseases (CVDs) are the main killers on a global scale. Each year, more people die from CVDs than from any other cause. An estimated 17.5 million deaths globally in 2012, or 31% of all fatalities, were caused by CVDs. Of these fatalities, 7.4 million were thought to be caused by coronary heart disease and 6.7 million by strokes. Most CVD mortalities happen in low- and middle-income countries. 82% of the 16 million deaths under 70 caused by non-communicable illnesses occur in low- and middle-income nations, and 37% of those deaths are attributable to CVDs [(1)].

The majority of cardiovascular disorders may be averted by implementing population-wide measures that focus on behavioral risk factors such as cigarette smoking, poor diet, obesity, inactivity, and problematic alcohol drinking. Those with cardiovascular illness or at high cardiovascular risk require early identification, treatment, and medication, due to the existence of one or more risk factors like hypertension, diabetes, hyperlipidemia, or an existing disease [(2)].

Despite the advancement of prophylactic medicine, CAD continues to be a leading global cause of mortality. Because early and stringent treatment of coronary risk factors can halt the advancement of coronary plaque instability in those individuals, detecting the presence of coronary arteriosclerosis is critical for primary CAD prevention. Nevertheless, identifying the early stages of coronary plaque can be challenging since modest plaque load often does not generate symptoms, even while exercising [(3)].

According to recent research, epicardial adipose tissue (EAT) mediates the development of arterial plaque and is linked to both catastrophic and nonfatal coronary events [(4)]. The coronary artery may be immediately impacted by inflammatory cytokines that are produced from peri-coronary EAT because EAT is located within the pericardial sac [(1)]. Abdominal visceral adipose tissue (VAT) is associated with plaque shape, and increased levels of inflammatory cytokines and reactive oxygen species may hasten the progression of this disease [(5)]. The development of CAD may be influenced differently by various kinds of adipose tissue depot, but this problem is not yet completely known [(6)].

There are several ways to measure visceral fat tissue, including direct methods using cost-prohibitive computed tomography and magnetic resonance imaging, as well as indirect methods using physical measurements, such as waist girth and body mass index (BMI) [(7)].

The most reliable method to assess visceral adiposity is magnetic resonance imaging, but the reliability of results based on single slice sampling has raised some questions (i.e., whole body magnetic resonance imaging scan is the true gold standard). In elderly people, the reliability of the waist measurement as a marker of visceral obesity may be reduced. Additionally, waist circumference rather than visceral obesity may be a stronger indicator of subcutaneous

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fat. Despite the fact that the waist circumference is a recognized indicator of intra-abdominal adiposity, anthropometric techniques that involve measuring the waist, such as the waist circumference and the waist-to-hip ratio, may overlook potentially confounding subcutaneous adipose tissue, especially in more obese people [(8)]. According to several studies, waist circumference, rather than body mass index, an anthropometric indicator of visceral adiposity, is a more accurate predictor of cardiovascular risk. This indicates that visceral obesity may not always be indicated by body mass index [(9)]. Echocardiography is a safe and non-invasive tool for EAT assessment. Because it could be a component of the routine evaluation that patients who are suspected of being at risk for cardiovascular or metabolic illness undertake, it is also relatively time and money effective. There are not many limitations [(4)].

EAT measurements may serve as a key to CAD risk classification as well as a quantitative predictor of metabolic disorders and systemic atherosclerosis. Therefore, using EAT thickness measurement in clinical practise could be very helpful in finding patients who are at risk, directing them to manage the risk factors properly, and, if necessary, subjecting them to additional examinations using invasive techniques [(10)].

The aim of the current study was to confirm the relationship between the epicardial adipose tissue thickness on echocardiography and CAD severity.

PATIENTS AND METHODS

A total of 200 patients who were candidates for coronary angiography due to chest discomfort (including both acute coronary syndrome and persistent stable angina) and/or an abnormal stress test were involved in the research after being directed to the catheterization laboratories at Ain Sham University Hospitals during the period from June 2013 to October 2014.

The research included patients with steady sinus rhythm and a normal anatomical chest. Patients with slow flow in the absence of any discernible lesions in coronary angiography, poor echogenicity, decompensated heat failure, history of percutaneous coronary intervention (PTCA) or coronary artery bypass graft surgery (CABG), chronic kidney disease, and pericardial and/or pleural effusion were excluded from the study.

All the studied population was subjected to full medical history as personal history and history of risk factors or other diseases with special emphasis on hypertension, diabetes mellitus, hyperlipidemia, cigarette smoking, renal impairment, and previous surgical history or cardiac intervention. Also, family history of ischemic heart diseases, sudden cardiac death and dyslipidemia.

Detailed transthoracic echocardiography with measurement of epicardial fat thickness was performed for all patients, in addition to a thorough clinical examination that included a full cardiological examination with measurement of BMI, waist hip ratio (WHR), laboratory investigations, a 12-lead ECG, chest X-rays, coronary angiography, and laboratory investigations.

Following coronary angiography, all patients experienced transthoracic echocardiography with a single operator using the Vivid S5, a 3.5 MHZ transducer-equipped GE (United States, probe number 2.5) device that can perform M-mode, 2D, and Doppler studies. When performing an echocardiogram, the technician was blinded to the findings of coronary angiography (healthy or diseased coronary arteries).

When epicardial fat was massive, it showed as a hyperechoic space on the left and right ventricles rather than as an echo-free area. There was a smattering of reflection in this gap that travelled along with the ventricles and was nearby. The epicardial fat had this trait. On the right ventricle free wall, this fat had the largest girth. The images from the parasternal long and short axis echocardiogram and the subcostal four chamber echocardiogram best showed this finding. There is no standard upper-limit number for EFT yet [(11)].

The study group was in the left lateral decubitus position since the parasternal long- and short-axis views allowed for the most precise assessment of epicardial fat at the right ventricle with the best cursor beam alignment. This site had the largest absolute epicardial fat layer thickness. The adipose layer was evaluated on the free wall of the right ventricle perpendicular to the aortic annulus at the end of systole. The average of 3 cardiac cycles for each echocardiographic picture was employed in the statistical analysis [(11)].

Ethical Consideration:

This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Ain Shams University. Written informed consent was obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical Analysis

The collected data were introduced and statistically analyzed by utilizing the Statistical Package for Social Sciences (SPSS) version 18.0 for windows. Qualitative data were defined as numbers and percentages. Quantitative data were tested for normality by Kolmogorov-Smirnov test. Normal distribution of variables was described as mean±standard deviation (SD), and minimum and maximum of the range. Independent sample t-test was used for comparison between groups. To evaluate the relationship between 2 normally distributed variables, Pearson correlation coefficients had been used. P value ≤ 0.05 was considered to be statistically significant.

RESULTS

Table (1) shows that EAT thickness ranged from 1.7 to 10.6 mm during the systole and from 1.5 to 10.2 mm as measured during systole and diastole respectively.

Table (1): Echocardiographic measurement of EATT.

Variable	Range (mm)	Mean ± SD
EATT(s)	1.7-10.6	5.39 ± 1.41
EATT(d)	1.5-10.2	5.09 ± 1.39

As shown in table (2), there was no significant correlation between sex and EATT(s), with P value of 0.260.

Table (2): The association between gender and EATT(s).

Sex	EATT(s)		Independent t-test	
	Mean ± SD	Range	t	P-value
Female	5.24 ± 1.02	2.5 – 8	1.130	0.260
Male	5.48 ± 1.52	1.7 – 10.6		

Table (3) shows that diabetic, hypertensive and smoker patients have more significant EATT(s) measurements when compared with patients who are non-diabetic, non-hypertensive and non-smokers.

Table (3): Comparison between risk factors and EATT(s).

Variable		EATT(s) (mm)		Independent t-test	
		Mean ± SD	Range	t	P-value
DM	Negative	4.82 ± 1.36	2.5 – 10.6	6.183	0.001
	Positive	5.94 ± 1.19	1.7 – 10.3		
HTN	Negative	5.05 ± 1.36	2.5 – 10.6	2.899	0.004
	Positive	5.62 ± 1.37	1.7 – 10.3		
Smoking	Negative	5.14 ± 1.3	1.7 – 10.6	3.465	0.001
	Positive	5.82 ± 1.43	2.8 – 10.3		

Measurement of EATT(s) was found to be highly significant (P<0.001) in patients with BMI ≥30 as shown in the table (4).

Table (4): Comparison between BMI and EATT(s).

BMI	EATT(s)		Independent t-test	
	Mean ± SD	Range	t	p-value
BMI < 30	5.05 ± 1.29	1.7 – 10.6	6.046	<0.001
BMI ≥ 30	6.26 ± 1.24	3.7 – 9.6		

Table (5) shows a highly significant correlation between WHR and EATT(s).

Table (5): Correlation between WHR and EATT(s)

Variable	EATT(s)	
	r	P-value
WHR	0.593**	<0.001

On measuring EATT(s), it was found that p value was highly significant in cases with high levels of LDL and TGs compared to corresponding values in persons with normal levels of LDL and TGs as illustrated in table (6). EATT was highly significant in patients with coronary affection when compared to corresponding values of normal individuals (Table 6).

Table (6): Comparison between serum lipids, CAD and EATT(s).

Variable		EATT (s) (mm)	Independent t-test	
		Mean ± SD	T	P-value
LDL (mg/dl)	<160 ≥160	4.78 ± 1.02 6.44 ± 1.3	10.040	<0.001
TGs (mg/dl)	<150 ≥150	4.71 ± 1.09 5.92 ± 1.36	6.785	<0.001
CAD	Normal CAD	4.22 ± 0.90 6.07 ± 1.16	11.706	<0.001

Table (7) shows that there is no significant correlation between gender and EATT(d). Also, measurement of EATT(d) was found to be highly significant in patients with BMI ≥30. While, diabetic, hypertensive and smoker patients have more significant EATT(d) measurements when compared with patients who are non-diabetic, non-hypertensive and non-smokers.

Table (7): Comparison between gender, risk factors and EATT(d).

Variable		EATT(d) (mm)		Independent t-test	
		Mean ± SD	Range	t	P-value
Gender	Female Male	5 ± 0.99 5.2 ± 1.48	2.4 – 7.7 1.6 – 10.2	0.946	0.345
DM	Negative Positive	4.82 ± 1.36 5.94 ± 1.19	2.5 – 10.6 1.7 – 10.3	6.183	<0.001
HTN	Negative Positive	4.78 ± 1.30 5.36 ± 1.33	2.3 – 10.2 1.6 – 9.9	3.0380	0.003
Smoking	Negative Positive	4.89 ± 1.26 5.52 ± 1.40	1.6 – 10.2 2.7 – 9.9	3.298	<0.001
BMI	<30 ≥30	4.8 ± 1.25 5.97 ± 1.21	1.6 – 10.2 3.5 – 9.3	6.083	<0.001

Table (8) shows a highly significant correlation between WHR and EATT(d).

Table (8): Correlation between WHR and EATT(d).

Variable	EATT(d)	
	r	**P-value**
WHR	0.581**	<0.001

On measuring EATT(d), it was found that p value was highly significant in cases with high levels of LDL and TGs compared to corresponding values in persons with normal levels of LDL and TGs as illustrated in table (9). EATT(d) was highly significant in patients with coronary affection when compared to corresponding values of normal individuals (Table 9).

Table (9): The correlation between serum lipids and EATT(d).

Variable		EATT (d) (mm)	Independent t-test	
		Mean ± SD	**t**	**P-value**
LDL (mg/dl)	< 160 ≥ 160	4.54 ± 0.99 6.13 ± 1.27	9.785	<0.001
TGs (mg/dl)	< 150 ≥ 150	4.47 ± 1.07 5.64 ± 1.32	6.743	<0.001
CAD	Normal CAD	4.02 ± 0.9 5.77 ± 1.13	11.261	<0.001

Table (10) shows that, of patients with normal coronaries, 16 patients were diabetics, 35 patients were hypertensive, 13 patients were smokers, 11 patients were obese, 34 patients had abnormal WHR, 7 patients had high serum LDL levels, and 30 patients had high triglycerides levels. The correlations between cardiac risk factors and the extent of CAD are summarized in table 10.

Table (10): The correlation between cardiac risk factors and the extent of CAD.

Variable		Normal CA		One Vessel CAD		Two vessels CAD		Three vessels CAD		Chi-square test	
		No.	%	No.	%	No.	%	No.	%	X^2	P-value
DM	Negative	56	77.8%	22	44.0%	12	22.6%	6	24.0%	45.323	0.000
	Positive	16	22.2%	28	56.0%	41	77.4%	19	76.0%		
HTN	Negative	37	51.4%	20	40.0%	18	34.0%	3	12.0%	12.892	0.005
	Positive	35	48.6%	30	60.0%	35	66.0%	22	88.0%		
Smoking	Negative	59	81.9%	31	62.0%	25	47.2%	7	28.0%	29.002	0.000
	Positive	13	18.1%	19	38.0%	28	52.8%	18	72.0%		
BMI	< 30	61	84.7%	41	82.0%	30	56.6%	10	40.0%	26.526	0.000
	≥ 30	11	15.3%	9	18.0%	23	43.4%	15	60.0%		
WHR	Normal	38	52.8%	14	28.0%	5	9.4%	4	16.0%	30.58	0.000
	Abnormal	34	47.2%	36	72.0%	48	90.6%	21	84.0%		
LDL (mg/dl)	< 160	65	90.3%	38	76.0%	20	37.7%	2	8.0%	73.142	0.000
	≥ 160	7	9.7%	12	24.0%	33	62.3%	23	92.0%		
TGs (mg/dl)	< 150	42	58.3%	29	58.0%	14	26.4%	1	4.0%	32.958	0.000
	≥ 150	30	41.7%	21	42.0%	39	73.6%	24	96.0%		

Table (11) shows a significant correlation between EATT (systolic and diastolic) and the number of coronary arteries diseased in CAD patients.

Table (11): Comparison between EATT and the extent of CAD.

Variable		One-Vessel disease (No. = 50)	Two-vessels disease (No. = 53)	Three-vessels disease (No. = 25)	Chi square test	
					X^2/f*	P-value
EATT(s)	Mean ± SD	5.26 ± 0.53	6.14 ± 0.76	7.52 ± 1.3	112.209	<0.001
	Range	3.8 – 6.3	4.2 – 8.1	5.9 – 10.6		
EATT (d)	Mean ± SD	4.98 ± 0.53	5.84 ± 0.72	7.19 ± 1.28	105.705	<0.001
	Range	3.5 - 6	3.9 - 7.6	5.4 – 10.2		

Table (12) shows that, according to our study, EATT(s) is the most powerful predictor of CAD (OR 8.464). EATT(d) also predicts CAD (OR 5.997). Other predictors of severe CAD are smoking, DM, HTN, WHR, and serum LDL levels. On the other hand, age, gender, serum triglycerides levels, showed not to be predictors of severe CAD.

Table (12): Logistic regression analysis for the predictors of CAD.

Variable	B	S.E.	Wald	Sig.	Odds ratio (OR)	95% CI for OR	
						Lower	Upper
Sex	0.304	0.543	0.314	0.575	1.356	0.467	3.932
Age	0.037	0.027	1.866	0.172	1.038	0.984	1.094
DM	1.97	0.442	19.899	**0.000**	7.168	3.017	17.03
HTN	1.168	0.423	7.636	**0.006**	3.216	1.404	7.365
Smoking	1.735	0.529	10.771	**0.001**	5.667	2.011	15.968
LDL	1.948	0.657	8.791	**0.003**	7.015	1.935	25.428
TGs	-0.188	0.487	0.149	0.700	0.829	0.319	2.151
BMI	0.054	0.566	0.009	0.924	1.055	0.348	3.202
WHR	1.235	0.449	7.566	**0.006**	3.44	1.426	8.295
EATT(s)	2.136	0.597	12.797	**0.000**	8.464	2.626	27.279
EATT(d)	1.791	0.267	44.918	**0.000**	5.997	3.552	10.126

The cut-off value of EATT to predict CAD with one-vessel CAD was 5 mm if measured during systole and 4.6 mm if measured during diastole. When assessed during systole or diastole, the cut-off value of EATT to forecast two-vessel CAD was 5.3 mm and 4.9 mm, respectively. When measured during systole or diastole, the cut-off number for EATT to forecast three-vessel CAD was 5.6 mm and 5.3 mm, respectively (Table 13).

Table (13): Cut-off values for EATT in prediction of one, two and three-vessel CAD.

Parameters	Cut off point	AUC	Sensitivity	Specificity	+PV	-PV
One-vessel CAD						
EATT(d)	>4.6 *	0.841	86.00	79.17	74.1	89.1
EATT(s)	>5 *	0.859	84.0	88.89	84.0	88.9
Two-vessel CAD						
EATT(d)	>4.9	0.954	96.23	90.28	87.9	97.0
EATT(s)	>5.2	0.959	98.11	90.28	88.1	98.5
Three-vessels CAD						
EATT(d)	>5.3 *	0.993	100.00	95.83	89.3	100.0
EATT(s)	>5.6	0.994	100.00	95.83	89.3	100.0

DISCUSSION

In the current research, we looked at whether echocardiographic evaluation of EAT is helpful for noninvasively detecting coronary arteriosclerosis changes and whether it is essential to identify coronary arteriosclerosis compared to abdominal VAT.

The study was conducted on 200 individuals admitted at Ain Shams University Hospitals during the period from May 2013 till October 2014. The age of patients ranged from 38 to 78 years old. They were 138 males (69%) and 62 (31%) females. Seventy eight patients were smokers (39%), one hundred and four patients were diabetic (52%), and one hundred and twenty two patients were hypertensive (61%).

In our study, diabetic, hypertensive and smoker patients had more significant EATT, both systolic and diastolic, when compared to non-diabetic, non-hypertensive and non-smoker ones.

When EATT was measured during both systole and diastole, it was discovered that individuals with high levels of LDL and TGs had p-values that were significantly different from those of people with normal levels of LDL and TGs (P-value 0.001).

Measurement of EATT, both systolic and diastolic, was found to be highly significant (P<0.001) in patients with BMI of ≥30 and abnormal waist hip ratio when compared to corresponding values of normal BMI and waist hip ratio**.**

Our findings indicated that EAT rose with ageing, but no discernible difference between men and females was observed for either EATT(s) or EATT (d).

Our findings are consistent with those of **Shemirani *et al.* [12],** who found a favorable association between EATT and LDL, BMI (P=0.001), serum triglycerides (P=0.04), and waist circumference (P=0.04). However, in contrary to our findings, epicardial fat thickness was higher in females**.**

According to **Aydin *et al.* [13]** research, there are significant correlations between mean EATT and total cholesterol, BMI, hypertension, and diabetes mellitus (P<0.05 for each association). Our findings support their findings. Contrary to what we discovered, mean EATT and LDL-C and smoking history did not have any statistically meaningful associations.

Epicardial fat was related to HDL, cholesterol, glucose, and diastolic blood pressure, according to **Iacobellis *et al.* [4].** However, there was no association between the assessment of epicardial fatty tissue and triglycerides.

Waist circumference and RVOT fat cushion thickness were found to be significantly correlated in another research by **Toufan *et al.*[10].** Additionally, there was only a significant correlation between the RVOT fat pad and metabolic diseases, including elevated LDL and TG. The rise in EAT was also significantly correlated with weight, waist size, and BMI.

According to **Mookadam *et al.* [14]**, EAT thickness greater than 5 mm was also linked to higher fasting blood sugar levels (serum glucose, 112 vs. 107.7 mg/dl, P=0.39) and systolic blood pressure (132 vs. 128 mmHg, P=0.28), and the lipid parameters for the metabolic syndrome also showed a trend for a positive association. However, there was no statistically significant correlation between EAT thickness greater than 5 mm and diabetes, hypertension, or cholesterol. Even with greater cut-off values for EAT thickness at 6 and 7 mm, this relationship failed to reach statistical relevance. It is noteworthy that these findings were obtained despite the fact that both groups had comparable BMIs (28.49 vs. 28.38) and BSAs (1.95 vs. 1.98 m2).

Additionally, they discovered that EAT thickness was unaffected by gender and that, with the exception of heart rate and total cholesterol, there were no discernible differences between men and girls in any of the measured characteristics.

In our study, systolic EAT was highly significant in patients with coronary affection when compared to corresponding values in normal individuals.

Our findings are consistent with the research by **Yaez-Rivera *et al.* [15].** They looked at 153 subjects who received transthoracic echocardiography and coronary angiography in a row (TTE). At the end of systole, the parasternal long and short axis pictures

of three consecutive cardiac cycles were used to calculate the EAT thickness on the free wall of the right ventricle. In order to ascertain the prevalence, severity, and extent of CAD, coronary angiograms were examined. They found that EAT was thicker in participants with CAD than in subjects without CAD in both the parasternal long axis (5.39±1.75 vs. 4.00±1.67 mm, P<0.0001) and short axis (5.23±1.67 vs. 4.12±1.77 mm, P=0.001) pictures.

Shemirani *et al.* [12] conducted another trial with 315 patients who underwent diagnostic CA, followed by transthoracic echocardiography to evaluate EATT. Following the removal of 23 patients, it was discovered that epicardial fat thickness ranged from 1 to 13.5 mm, with the normal group's mean thickness being 4.4 (SD 1.8) mm and the CAD group's mean thickness being 5.4 (SD 1.9) mm, both of which were statistically significant (P<0.0001). This is consistent with our findings.

Our research is in accord with a study by **Bastarrika *et al.*[16].** In order to rule out CAD, 45 people received both traditional coronary angiography and cardiac dual-source CT. EAT was measured using non-enhanced pictures that were taken to determine the calcium value. Gensini ratings were used to grade the degree of coronary stenosis on traditional coronary angiograms. To acquire mean values, two separate observers measured the right ventricular EAT thickness manually at three distinct levels and in two different planes (four chamber and short axis). A widely accessible software tool was also used to automatically calculate EAT volume. Using conventional coronary angiography, it was found that 23 individuals had significant coronary artery stenosis and 22 subjects had non-significant coronary arteries. Volumetric assessment of EAT and BMI, arterial artery calcification, and Gensini score all showed significant relationships. Patients with significant coronary artery stenosis had considerably larger EAT volumes on automatic volumetry (154.58±58.91 vs. 120.94±81.85 mL; P=0.016) than patients without significant CAD.

Our findings are consistent with a research by **Yun *et al.*** [17] in which 153 patients who underwent elective coronary angiography for chest discomfort were given the option of transthoracic echocardiography, which evaluated the EAT and mediastinal adipose tissue (MAT). We looked at the relationships between cardiac adipose tissue and the prevalence and degree of CAD. Although MAT was unaffected by the existence of CAD (2.9±2.8 vs. 3.5±2.5 mm, P=0.121), EAT was thicker in subjects with CAD (1.8±1.4 vs. 3.8±1.9 mm, P<0.001).

A total of 150 subjects (100 with CAD and 50 with normal coronary arteries as determined by diagnostic coronary angiography; 65 women and 85 men; mean age 55.7±7.4 years) participated in a research by **Eroqlu *et al.*** [18]. The parasternal long- and short-axis images of a 2-D echocardiogram were used to quantify EAT thickness. EAT thickness readings and angiographic results were compared. When compared with those with normal coronary arteries, patients with CAD had substantially thicker EATs (6.9±1.5 mm vs. 4.4±0.8 mm; P<0.001). Moreover, when CAD severity rose, the EAT thickness did too (7.4±1.2 mm for multivessel disease vs. 5.7±1.7 mm for single vessel disease; P<0.001). CAD prediction accuracy was 85% sensitive and 81% specific for EAT thickness of 5.2 mm (ROC area 0.914, P<0.001, 95% CI 0.86-0.96).

During their first coronary angiography, **Mustelier *et al.*** [19] examined 250 Hispanic patients (86 women and 164 men, mean ages 61.5±8 vs. 62±10 respectively). Using 2D-echocardiography, cardiac fat accumulation characteristics were assessed the day following the coronary angiography. The occurrence of CAD was significantly and independently correlated with both epicardial fat (OR 1.27, P=0.009) and right ventricle fat infiltration (OR 2.94, P=0.027), but not with its extent (P=0.516).

Our findings are consistent with the research by **Aydin *et al.*** [13]**.** 150 individuals (73 [48.6%] female and 77 [51.3%] male; mean age, 49.30±12.6; range, 25-85 years) participated in the research. It stated that the mean EATT and calcium value had meaningful correlations. In each of the three coronary arteries (left anterior descending artery, P<0.001; left circumflex artery, P=0.038; right coronary artery, P=0.002; Table 3), patients with CAD had substantially greater EATT than patients without CAD. Additionally, mean EATT was considerably greater in CAD patients compared to non-CAD patients.

In a different research, EAT volume was measured using multidetector computed tomography (MDCT) on 624 consecutive individuals, who were carefully examined by **Narumi *et al.*** [20]. After adjusting for age, gender, body mass index, and diastolic blood pressure, they discovered that increased EAT volume (≥35 millilitre mean EAT volume) was independently related with CAD (odds ratio 1.9, 95% confidence interval 1.0-3.6).

Picard *et al.*[21] assessed the epicardial fat thickness in participants from the prospective EVASCAN study using computed tomography (CT) and assessed the incidence and severity of CAD using coronary angiography. Multivariate regression analysis was used to evaluate the relationship between EAT width and angiographic CAD. When compared to patients without angiographic CAD, they found that patients with angiographic CAD had denser EAT on both the left and right ventricular lateral walls (2.74±2.4 mm vs. 2.08±2.1 mm; P=0.0001 for LVLW and 5.58±3.1 mm vs. 4.77±2.7 mm; P=0.0004 for RVLW).

Oikawa *et al.* [22] investigated the possibility that various adipose tissue storage types might have varying effects on the development of CAD. We looked at 174 individuals who had both a CT and an echocardiogram. They noted that patients with coronary calcification had significantly larger EAT thickness as measured by TTE and area as measured by CT than patients without it (EAT: 7.1 mm (4.4-10.5 cm2) vs. 5.5 mm (3.7-7.3 cm2), P<0.01).

According to **Groves *et al.*** [23]**,** there was a strong correlation between having >120 cm3 of EAT and having serious CAD (adjusted odds ratio 4.47, 95% confidence range 1.35 to 14.82). They discovered that, in addition to being a standalone predictor of CAD, EAT volume also indicated CAD severity, even after adjusting for CAC score.

Pericardial fat secretes inflammatory mediators like monocyte chemotactic protein 1, IL-6, and TNF-α more frequently than subcutaneous fat [24]**.**

Inflammatory cells enter the vascular wall as a result of the existence of inflammatory mediators in the tissues near coronary arteries [25]**.** Additionally, findings from both human and animal research point to the absence of atherosclerotic plaques in the coronary artery portions devoid of pericardial fat [26]**.** Additionally, it has been found that people with normal coronary arteries release more of the anti-inflammatory cytokine adiponectin in their pericardial tissue than do people with serious CAD [27]**.**

On the other hand, a study by **Gorter *et al.*** [28] on a group of patients with a 70% male prevalence and a mean age of 616 years found no correlation between EAT and pericoronary fat, as assessed by cardiac CT, and the severity of coronary atherosclerosis and the extent of CAC in patients with suspected CAD. Nevertheless, in individuals with low BMI, EAT volume and pericoronary fat deposition were linked to more stenotic coronary arteries and more severe CAD.

The amount of seriously damaged coronary arteries in CAD patients and the echocardiographic EATT both significantly correlated in the current research.

It was demonstrated by **Toufan *et al.*** [10]**.** Significant association between the number of arteries impacted and the amount of coronary artery stenosis (50%; P=0.004) was found.

This was demonstrated by **Picard *et al.*** [21] in their research, it showed a positive correlation between increased LVLW EATT and the degree or extent of CAD. The mean LVLW EAT thickness ranged from 2.08±2.1 mm in patients with no or mild vascular disease to 2.43±2.4 mm in those with single artery disease, 2.65±2.2 mm in patients with left main disease, and 2.95±2.5 mm in patients with left main + right CAD (P for trend = 0.0001).

On the other hand, **Mustelier *et al.*** [19] discovered that there was no difference in the thickness of epicardial fat between those with multivessel CAD and those with two or one vessel (7±3 mm vs. 6.6±2.8 vs. 6.4±2.6 mm respectively, P=0.516).

Although patients with acute coronary syndrome had more epicardial fat than those with stable angina, there was no significant variation in epicardial fat thickness between the two groups (6.45±2.9 mm vs. 5.91±1.7 mm, respectively, P=0.153).

The ability to forecast CAD was 65.4% sensitive and 61.5% specific for epicardial fat thickness 5.2 mm (ROC area 0.712, 95% CI 0.640-0.784).

We discovered that EATT significantly associated with severe CAD in subjects with one-vessel CAD, irrespective of smoking, BMI, and serum lipids. EATT significantly associated with two-vessel CAD patients, irrespective of BMI. All cardiac risk variables (smoking, diabetes, hypertension, BMI, WHR, serum LDL, and serum TGs) were significantly correlated with echocardiographic EATT in subjects with three-vessel CAD.

Our regression analysis revealed that, with a significance of P<0.000 and odds ratio of 8.464, EATT(s) is a potent indicator of serious CAD. Echocardiographic EATT could be regularly done in high-risk patients for the assessment of epicardial adipose tissue and CAD prediction because it is a non-invasive, inexpensive, and widely accessible procedure.

EATT measured during diastole by TTE is also a predictor of severe CAD, though less significant than EATT measured during systole. So, we recommend measuring at least the systolic EATT in prediction of CAD.

Our study conducted cut-off values of both systolic and diastolic EATT for predicting severe CAD: The cut-off value of EATT to predict CAD with one-vessel CAD was 5 mm if measured during systole and 4.6 mm if measured during diastole. The cut-off value of EAT to predict two-vessel CAD was 5.3 mm if measured during systole and 4.9 mm if measured during diastole. The cut-off value of EAT to predict three-vessel CAD was five 5.6 mm if measured during systole and 5.3 mm if measured during diastole.

Depending on the interaction between epicardial fat and right ventricular fat infiltration, which occurs to varied degrees of severity, **Mustelier *et al.*** [19] outlined an echocardiographic categorization of the amount of cardiac fat deposition: I: 5.2 mm of epicardial fat; II: 5.2 mm of epicardial fat; III: 5.2 mm of epicardial fat and right ventricular fat accumulation. According to the strength of these correlations, the prevalence of significant CAD rose proportionately and considerably (P=0.001).

Our study conducted that smoking history, presence of DM or HTN, or high serum levels of LDL can also predict the presence of severe CAD. Meanwhile, the age, gender, BMI, and serum

triglycerides levels showed no significance in predicting severe CAD.

According to our results, WHR showed to be a predictor of severe CAD while BMI did not. For many years, the most commonly used way of finding a healthy weight was the body mass index. It is not without flaws, though. Body mass is not a reliable foundation for assessment in the case of an athlete, for instance, because muscle weights more than fat. Additionally, not all individuals with high BMIs and small waistlines are at elevated risk of having a heart attack.

According to a recent research that will be published in the Lancet, the waist-hip ratio may be a more accurate measure of fat (WHR). Because the WHR technique evaluates fat distribution, whereas BMI does not, scientists think it is a superior predictor than BMI. People who are android or "apple" shaped (fat around waist & upper abdomen)—as opposed to those who are gynoid or "pear" shaped (fat in thighs and buttocks) are more likely to suffer a heart attack. Some individuals may have a balanced amount of fat in both places.

People who are "android" or "apple" formed are more likely to develop obesity-related illnesses like hypertension, cardiovascular disease, and diabetes. In fact, the most recent study demonstrates that WHR was a three times more accurate indicator of heart attack than Obesity.

CONCLUSION

Our research showed a significant correlation between EAT and the existence and severity of CAD. It supports the idea that epicardial fat may contribute to the development of CAD, presumably through paracrine or vasocrine pathways. EAT may be evaluated safely and non-invasively by echocardiography, as it may be a component of the normal evaluation of individuals suspected of being at risk for cardiovascular or metabolic disorders.

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