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ORIGINAL ARTICLE

Correlation of Epicardial Fat Thickness and Severity of Coronary Plaque Lesion Using Echocardiography and Cardiac Multidetector Computed Tomograph

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ABSTRACT

Background: Epicardial fat is considered a part of visceral fat depot; it surrounds the myocardium just underneath the visceral pericardium where it has close proximity to the coronaries. Researches proof that epicardial adipose tissue is biologically active and so it may have a significant role in the occurrence and severity of atherosclerotic CAD. Advances in cardiovascular imaging techniques make echocardiography and MDCT accurate enough to assess both epicardial fat thickness (EFT) and epicardial fat volume (EFV) respectively.

Methods: One hundred participants were recruited in this cross-sectional study from January to December 2022. Patients were referred to Kobri El Kobba Military Hospital with suspected CAD for multi-slice CT angiography.

Results: Patients were classified into two groups according to the results of the CT coronary angiography; group (I) with significant CAD, 82 cases and group (II) without significant CAD, 18 cases. We further divided the 82 patients in group I into 3 subgroups, **Ia** (multivessel disease or proximal LAD and proximal LCX lesions), **Ib** (two vessels disease) and **Ic** (single vessel disease other than proximal LAD and proximal LCX lesions). There was a statistically significant difference between group I and group II regarding BMI, HTN, DM, total cholesterol, LDL, HDL, triglycerides, LDL/HDL ratio, EF (%), RSWMA, Epicardial Fat volume (EFV) measured by MDCT and Epicardial fat thickness (EFT) measured by Echocardiography. There was no statistically significant difference between the subgroups Ia, Ib and Ic regarding EFT measured by Echocardiography. EFV measured by MDCT is the most statistically significant predictor for severe CAD or multi-vessel disease.

Conclusion: Epicardial fat depot was significantly associated with plaque development and vulnerability where EFT and EFV showed high values and were closely related to CAD presence and severity.

Keywords: Epicardial fat thickness; Epicardial fat volume, Coronary plaque; Echocardiography; Cardiac multidetector computed tomography.

INTRODUCTION

Coronary artery disease (CAD) is considered as pathological phenomenon this is distinguished by the buildup of atherosclerotic plaque in the epicardial arteries, regardless of whether it causes obstruction or not. The process above has the potential to be altered through lifestyle modifications, pharmaceutical treatments, and invasive procedures with the aim of attaining illness stabilization or regression. The disease exhibits periods of extended stability, however, it is susceptible to sudden fluctuations at any given moment. The CAD process has a dynamic nature, leading to diverse clinical manifestations that can be manifested as either acute coronary syndromes (ACS) or chronic coronary syndromes (CCS) [1].

The epicardial adipose tissue, which is positioned between the visceral pericardium and the heart and envelops the coronary arteries, is widely considered to be a potential risk factor for CAD [2]. It remains uncertain whether an elevated EFV is correlated with an increased probability of developing atherosclerosis or a concurrent rise in coronary plaque volume [3].

The echocardiographic evaluation of the EFT provides a distinct indication of visceral adiposity as opposed to overall obesity. It exhibits a correlation with subclinical atherosclerosis, insulin resistance, metabolic syndrome, and coronary artery disease (CAD). Consequently, it has the potential to function as a straightforward instrument for predicting cardiometabolic risk [4].

Multi-slice CT is known to be a non-invasive and dependable method for evaluating obstructive and non-obstructive subclinical CAD at early stages compared to angiography which is considered to be more invasive that MSCT. It offers valuable information regarding the existence of coronary artery stenosis, calcium accumulation, the morphology and composition of coronary atherosclerotic plaques, and the evaluation of effective fractional volume (EFV), even in the absence of contrast injection [5].

METHODS

One Hundred patients were recruited and signed an informed consent that was approved by the ethics committees in Zagazig University Hospitals. All studied participants complained from chest pain with low / intermediate Pre- Test Probability (PTP) of CAD according to Diamond and Forrester of CAD. Patients with renal insufficiency, previous revascularization, recent AMI, irregular and unstable rhythms, as well as those with morbid obesity and dye allergy were excluded

All patients were subjected to: Detailed history taking, clinical assessment, standard 12 lead surface ECG, routine laboratory investigations and Multi-slice CT angiography using Siemens Somatom Definition Flash device (Erlangen-Germany) where measurement of plaque burden and EFV was done; Figure (1) .

Echocardiography was done using SIEMENS ACUSON S2000 and a probe's frequency range of 2-4 MHz. All echocardiographic parameters were analyzed depending on the American Society of Echocardiography guidelines (Left ventricle systolic function (LVSF), Left ventricle diastolic function (LVDF) and Right ventricle (RV) assessment).

The visualization of epicardial fat thickness and its measurements can be achieved by the utilization of typical two-dimensional echocardiography techniques. The utilization of standard parasternal long_axis and short_axis views enables the acquisition of highly precise measurements of epicardial fat thickness (EFT) situated above the right ventricle. Echocardiographic Free Space (EFT) is often recognized as the absence of echoes between the outer wall of the myocardium and the visceral layer of the pericardium. It is typically quantified by measuring the distance perpendicular to the free wall of the right ventricle during end-systole. The range of echocardiographic EFT measurements is from 1 mm to 23 mm [6].

Data management:

The data obtained over time, along with the routine clinical assessment, laboratory results, along with echocardiographic findings and outcomes, were collected, recorded, and interperted using the Excel computer software. The data was subsequently interpreted with the Statistical Package for the Social Sciences (SPSS version 20.0) computer software for the purpose of statistical analysis. In academic research, qualitative data is typically provided in the form of numbers and percentages, allowing for a descriptive analysis of the data. On the other hand, quantitative data is commonly represented using the mean value accompanied by the standard deviation (SD), which provides a scale of the variability and dispersion of the data surrounding the mean. The current study employed two statistical correlations tests, namely Pearson's and Spearman's-rank coefficient, to examine significance and directions of the differences between variables. A significance level of $p \leq 0.05$ was applied to determine statistically significant values, while a more stringent threshold of $p \leq 0.001$ was applied for highly significant results.

RESULTS

The studied participants were splitted into two groups, according to the CT coronary angiography results, Group I: Patients with significant CAD including 82 participants, Group II: Those without significant CAD including 18 participants.The mean BMI in group I was 27.72±1.61 while for group was II 24.35±0.34 ; P value <0.001). Regarding risk factors; hypertension and diabetes were more prevalent in group I patients with high statistical significant difference, Table (1).

Regarding lipid profile; group I patients showed higher serum cholesterol, LDL, serum TG and risk ratio (LDL/HDL) and lower HDL in comparison to patients among group II (p<0.001) as shown in Table (2)

Comparing echocardiographic data of both groups; group I patients had diastolic dysfunction and had lower systolic function and more RWMSA, Table (3)

The analysis of the diagnostic performance for EFV measured by MDCT and EFT measured by Echocardiography showed statistically significant increase in EFT and EFV in patients of group (I) with CAD with (P<0.001) as the median EFT was 5(5-6) mm in group (I) while it was 2.5(2-3) in group (II). The median EFV was 149.85(122.9-186.2) in group (I) while it was 83.08(71.8-91.3) in group (II). (Figure 2)

Group I patients was further subdivided into 3 subgroups according to significance; Ia (n=51) (multivessel disease or proximal LAD and proximal LCX lesions), Ib (n=5) (two vessels disease) and Ic (n=26); (single vessel disease other than proximal LAD and proximal LCX lesions). Regarding demographic data only BMI was significantly higher in group Ia in comparison to Ib and Ic (p = 0.026). Patients in Group Ia had more diabetic cases among the three groups (p ≤0.001), yet no statistically significant difference regarding other risk factors exist.

Comparing lipid profile among the three subgroups there was no statistical difference among them (P-value > 0.05). There was a statistically significant difference among Ia, Ib and Ic subgroups regarding EF % and RSWMA where group Ia had lower LVEF and more RSWMA (p < 0.001). Concerning the epicardial fat data; patients with severe CAD had increased EFV measured by MDCT (p<0.001) whilst EFT captured by echocardiography wasn't that significant Table (4), data confirmed by ordinal regression analysis as well.

Our study reported that there was a statistically significant positive correlation between Segmental involvement score (SIS score) and summed stress score (SSS score) regarding EFT and EFV. Also, there was a significant positive correlation between EFT, EFV with age, BMI, serum cholesterol, LDL, serum triglycerides and risk ratio (LDL/HDL), on the contrary HDL correlated negatively (p<0.001).

On plotting the ordinal regression analysis, the EFV measured by MDCT is the most statistically significant predictor for multi-vessel disease and the severity of CAD with (Odds ratio 1.043) and (P value<0.05). (Table 5)

ROC analysis for EFV predicting presence of CAD disease showed AUC 0.966 with a cut_off value of 102.6 cm³ had sensitivity 87.8% and specificity 100 %, and for EFT in CAD prediction AUC was 0.98 with a cut_off value of 3mm had sensitivity 97.6 % and specificity 94.4%, P value < 0.001. (Table 6) (Fig. 3a).

ROC analysis for prediction of CAD disease severity showed a cut off value of 155.4 cm³ for EFV (AUC 0.931;sensitivity 82%, specificity 91.8 % and that of EFT showed a cut off value of 4mm (AUC 0.753; sensitivity 84.6%, specificity 50.8 %), P value <0.001. (Table 7) (Fig. 3b)

Table 1: Risk Factors of both groups

	Group I (82) n%	Group II (18) n%	P
HTN	48 (58.5 %)	0 (0%)	**<0.001****
DM	57 (69.51%)	0 (0%)	**<0.001****
Smoking	46 (56.1%)	6 (33.3%)	0.08
FH of CAD	16 (19.5%)	0 (0%)	0.069

HTN: Hypertension, DM: Diabetes, FH: Family History, CAD: Coronary Artery Disease

Table (2): Lipid profile of both groups

	Group I (82)	Group II (18)	P Value
	Mean ± SD	Mean ± SD	
S. Cholesterol (mg/dl)	225.02 ± 27.51	150.06 ± 10.59	**<0.001****
LDL (mg/dl)	178.84 ± 32.55	86.39 ± 10.94	
HDL (mg/dl)	39.01 ± 9.44	61.61 ± 1.82	
S. Triglycerides (mg/dl)	169.48 ± 23.82	120.22 ± 6.4	
Risk ratio (LDL/HDL)	4.9 ± 1.53	1.36 ± 0.19	

Table (3): Echocardiographic data of both groups

	Group I (82) n. %	Group II (18) n. %	P
EF % Mean ± SD	55.76 ± 5.6	65.72 ± 3.59	**<0.001****
Patients having diastolic dysfunction	76 (92.6%)	5 (27.7)	
Patients having RWMSA	60 (73.1%)	0 (0%)	

EF: Ejection Fraction

Table 4: Epicardial fat data among the three subgroups

	Groups			P value
	Ia	**Ib**	**Ic**	
	Median (IQR)	Median (IQR)	Median (IQR)	
EFT (mm)	5 (5 - 6)	5 (5 - 5)	6 (4 - 7)	0.195
EFV (cm3)	174.6 (145.5 - 192.7)	171.5 (162.9 - 176.9)	112.4 (100.6 - 122.9)	**<0.001****

EFT: Ejection Fraction Thickness, EFV: Ejection Fraction Volume

Table 5: Ordinal regression analysis of predictors of severity of CAD

	Odds ratio	95% confidence interval for odds ratio		p-Value (Sig.)
		Lower bound	**Upper bound**	
Age (Years)	0.912	0.824	1.008	>0.05
S. Cholesterol (mg/dl)	0.977	0.880	1.084	>0.05
LDL (mg/dl)	1.022	0.912	1.147	>0.05
HDL (mg/dl)	1.148	0.862	1.528	>0.05
S.Triglycerides (mg/dl)	1.031	0.976	1.089	>0.05
Ca score	1.005	0.997	1.012	>0.05
EFT (mm)	0.933	0.412	2.114	>0.05
EFV (cm3)	1.043	1.006	1.082	<0.05

EFT: Ejection Fraction Thickness, EFV: Ejection Fraction Volume

Table 6: Roc curve of EFT and EFV to predict presence of coronary heart disease

	AUC	95% CI	Sig.	Cut-off value	Sensitivity	Specificity	+PV	-PV
EFT (mm)	0.987	0.941 to 0.999	<0.001	>3	97.6	94.4	98.8	89.5
EFV (cm^3)	0.966	0.910 to 0.992	<0.001	>102.6	87.8	100	100	64.3

EFT: Ejection Fraction Thickness, EFV: Ejection Fraction Volume

Table 7: Roc curve of EFV to predict severe CAD (multi vessel disease, LM disease or proximal LAD, LCX lesions)

	AUC	95% CI	Sig.	Cut-off value	Sensitivity	Specificity	+PV	-PV
EFT (mm)	0.753	0.842 to 0.925	<0.001	>4	84.6	50.8	65.2	86.7
EFV (cm^3)	0.931	0.862 to 0.972	<0.001	>155.4	82.05	91.8	86.5	88.9

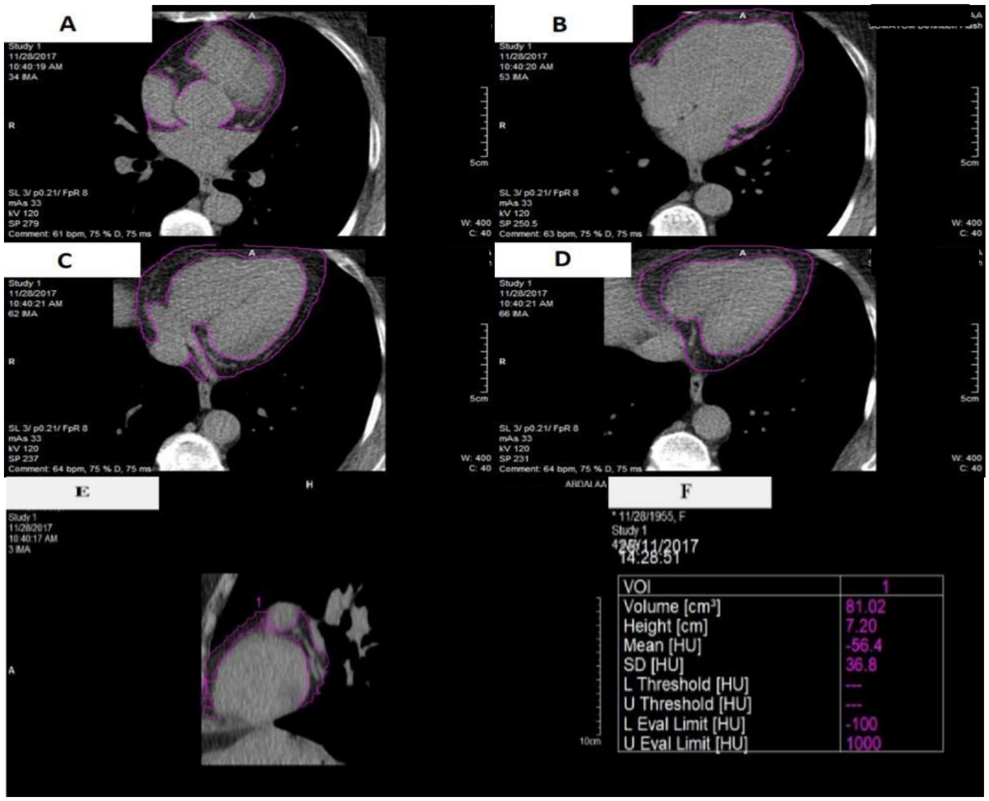


Figure (1): Measurement of epicardial fat volume (EFV) by computed tomography. The area of interest was defined by the manual delineation of the epicardial fat and the volume was calculated in a semi-automatic way by specific software as shown in slide (F) 81.02 cm3.

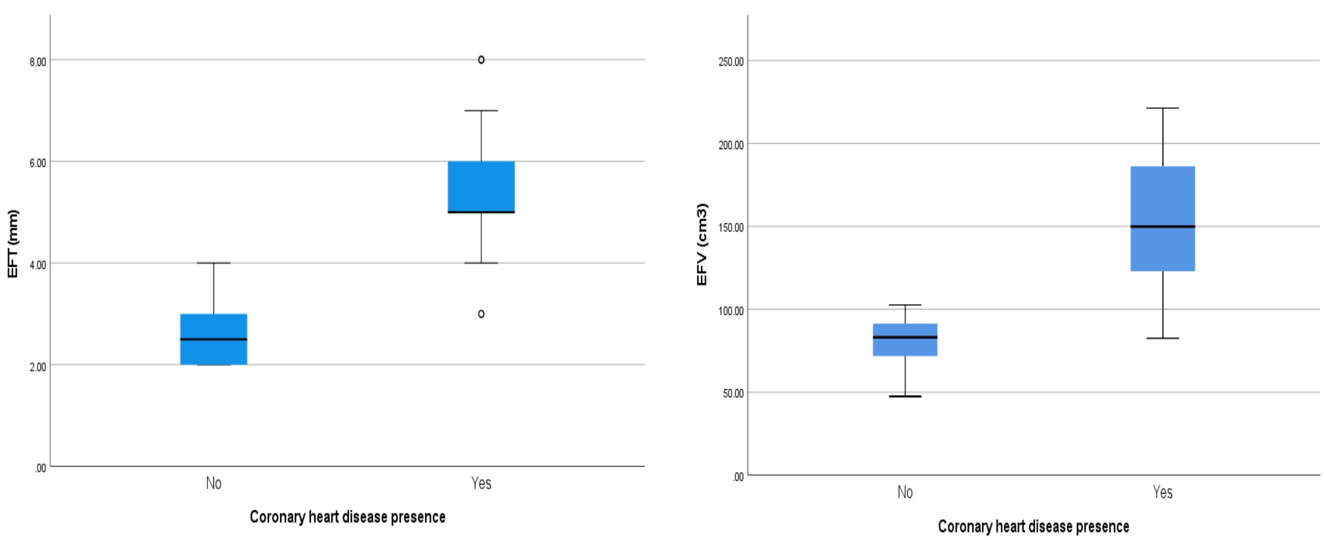
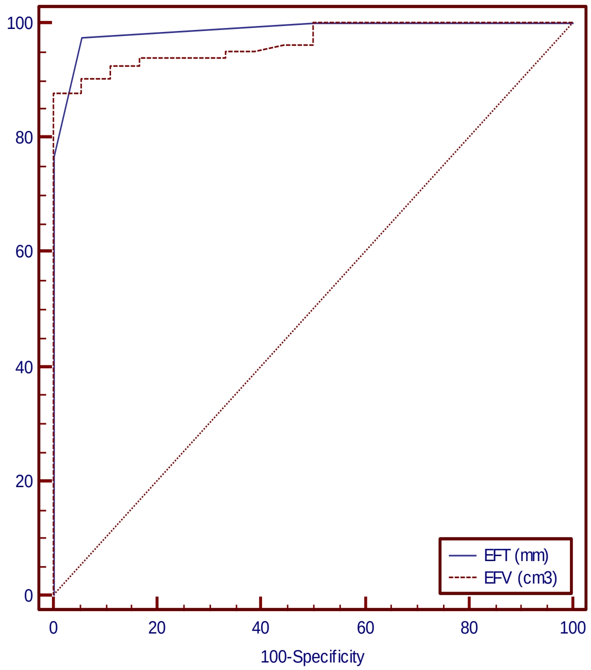
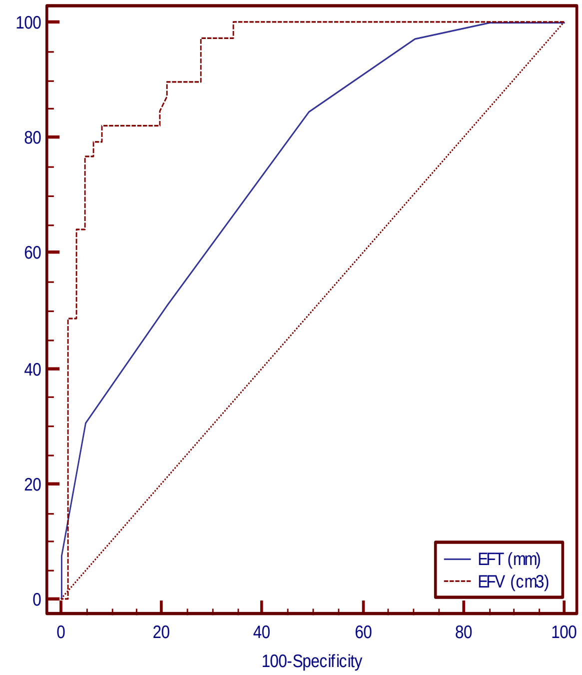


Figure (2): Median values of EFT (a) and EFV (b) in both groups



3a.



3b.

Figure (3): ROC analysis of EFT, EFV for prediction of CAD and its severity.

DISCUSSION

Epicardial fat as a part of visceral adiposity plays a significant role in the development and vulnerability of coronary artery plaques [1]. Epicardial fat thickness measured by echocardiography showed significant association with CAD and as MDCT modality became highly advanced it provides better quantification of EFV as well as assessment of CAC and severity (plaque composition and vulnerability) [7] [8].

Our study found significant association between most traditional risk factors as hypertension and diabetes apart from smoking and family history compared to Khurana et al. [9]

Patients in our study were predominantly males which was in concordance with that of Hassan A et al, [10] who had a population with even distribution concerning the gender.

Epicardial fat thickness and epicardial fat volume were higher among group I participants in comparison to patients without significant CAD, these data was in concordance with Meenakshi et al, [11] emphasizing the prominent role of epicardial adiposity in coronary plaque development and its vulnerability

Our study revealed that on multivariate analysis, EFV was considered as an independent risk factor for coronary artery disease and its severity which was in concordance with Cheng et al., [12] and Harada et al, [13]. Our study showed cut off values for EFV 102.6 cm3 to be highly significant (specificity 87 %, sensitivity 100%), and a cut off value of significance for EFT was 3 mm (sensitivity 97.6%, specificity 94.4%).

Conclusion

Traditional risk factors including age, body mass index, hypertension, diabetes mellitus, impaired lipid profile showed significant correlation with coronary heart disease presence and significance. EFT and EFV were independent risk factors for multi vessel disease what makes quantification of epicardial fat of great usefulness.

Conflict of Interest: None

Financial Disclosures: None

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