

Correlation Between Epicardial Fat Thickness Measured By Echocardiography And Coronary Artery Disease Severity Using The Gensini Score

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Abstract

Objective: To investigate the relationship between epicardial fat thickness (EFT) and the severity of coronary artery disease (CAD) and determine an EFT cutoff value for CAD prediction.

Methods: A correlational study was conducted at the Rawalpindi Institute of Cardiology with 113 patients undergoing coronary angiography. EFT was measured using echocardiography, and CAD severity was assessed using the Gensini Score. Pearson's correlation and receiver operating characteristic (ROC) analysis were used for statistical evaluation.

Results: A significant positive correlation was observed between EFT and Gensini Score ($r = 0.749$, $p < 0.01$). The EFT cut-off for predicting CAD was 4.50 mm, with a sensitivity of 89.8% and an area under the curve (AUC) of 0.920. Waist-to-hip ratio also correlated significantly with CAD severity, while BMI showed a weaker correlation.

Conclusion: EFT is a reliable and non-invasive marker for CAD severity, with significant implications for risk assessment and management.

Keywords: Epicardial Fat, Coronary Artery Disease, Gensini score

Introduction

Coronary artery disease (CAD) remains a leading cause of death and disability worldwide, significantly impacting global health. According to the Global Burden of Disease Study 2019, CAD was responsible for an estimated 9.48 million deaths and 196.7 million years of disability-adjusted life years in 2019 alone.¹ CAD is characterized by atherosclerotic plaque build-up in coronary arteries, leading to ischemia and myocardial damage.² Traditional risk factors, such as hypertension, diabetes, hyperlipidemia, and smoking, are well-documented, but there is increasing interest in novel markers to improve early detection and risk stratification. Epicardial fat thickness (EFT), located between the heart's outer surface and visceral pericardium, is a metabolically active tissue that secretes pro-inflammatory cytokines, contributing to atherosclerosis. Unlike subcutaneous fat, EFT's proximity to coronary arteries implicates it as a potential mediator of CAD.³ Epicardial fat thickness has appeared as a novel and important factor in cardiovascular health, with growing evidence suggesting its association with various cardiovascular diseases, comprising CAD, heart failure, and atrial fibrillation.⁴ All this new evidence has led us to believe that regional thoracic fat depots, epicardial fat in particular, are a strong CAD predictor. Uncertainty exists regarding the exact processes that support the link between EFT and cardiovascular illnesses, but several hypotheses have been proposed. EFT is thought to have both local and systemic effects on cardiovascular health. Locally, EFT has been shown to have a direct impact on the adjacent myocardium, with epicardial adipose tissue releasing pro-inflammatory cytokines, adipokines, and free fatty acids, which can have detrimental effects on the myocardium, including inflammation, fibrosis, oxidative stress, and impaired myocardial contractility.⁵ These local effects might help the progression of Atherosclerosis, plaque formation, and subsequent CAD.

Contributions:

M.A.B - Conception of study
- Experimentation/Study Conduction
G.Z.K.N - Analysis/Interpretation/Discussion
G.Z.K.N, M.A.B - Manuscript Writing
G.Z.K.N - Critical Review

All authors approved the final version to be published & agreed to be accountable for all aspects of the work.

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Systemically, EFT is a factor that is thought to be involved in the aetiology of cardiovascular disorders through its endocrine and metabolic effects. Epicardial adipose tissue is highly metabolically active and can release adipokines and cytokines that can have systemic effects on glucose metabolism, insulin resistance, lipid metabolism, and endothelial function, all of which are crucial elements to the emergence of cardiovascular disorder.⁶

Echocardiography is a reliable tool for assessing EFT in various populations, including individuals with obesity, diabetes, and cardiovascular diseases, and has been used in numerous research studies to examine the link between EFT and cardiovascular health.⁵ EFT is measured as the distance between the outer wall of the myocardium and the visceral layer of the pericardium, typically at end-diastole in the parasternal long-axis view.⁵ The depth from the right ventricle free wall can be assessed in the parasternal long and short axis windows of a transthoracic echocardiography as an echo-free space above the right ventricular free wall. EFT can be determined non-invasively using numerous imaging techniques, and its role as an independent risk factor for cardiovascular diseases has yet to be established.⁴ This study explores the correlation between EFT and CAD severity using the Gensini Score and aims to establish an EFT cutoff for CAD risk prediction.

Materials And Methods

This was a correlational study conducted over 12 months, conducted at the Rawalpindi Institute of Cardiology.

A total of 113 patients undergoing coronary angiography were enrolled. A sample size of 113 is estimated by using a confidence level of 95% with the power of study as 90% and assuming the relation between EFT and the severity of CAD as 0.30⁸.

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{\frac{1}{4} \left[\log_e \left(\frac{1+r}{1-r} \right) \right]^2} + 3$$

Where:-

$Z_{1-\beta}$ is the desired power of study = 90%.

$Z_{1-\alpha}$ is the desired confidence level = 95%

r is the correlation of EFT with severity of CAD = 0.30

n = calculated sample size = 113

Adults aged 18–70 years with suspected CAD were included in the study. Patients with structural heart anomalies, chronic lung diseases, previous coronary interventions, or inadequate echocardiographic windows were excluded from the study.

Data was collected from 113 patients achieving the selection standards and were enrolled in the study from the Post Cardiac Catheterization Ward of Rawalpindi Institute of Cardiology, Rawalpindi. A self-structured questionnaire was used after taking informed consent from each patient and explaining the study objective. EFT is an autonomous variable, and coronary artery disease severity will be a dependent variable. EFT was measured by a consultant cardiologist with at least 3 years post-fellowship experience of doing transthoracic echocardiography. An echo-free space between the right ventricular free wall and visceral pericardium was identified, and measurements were performed perpendicularly to the free wall of the right ventricle in the parasternal long-axis in end systole for 3 cardiac cycles. The mean value from these three cardiac cycles was utilized for the statistical evaluation. Pericardial effusion was differentiated from epicardial fat as effusion. While the fat layer moves in sync with the heart, it is often immobile, echo lucent, and circular rather than localized to the area surrounding the right heart and is a non-circumferential accumulation. Echocardiography was performed by a single operator in all cases, and all these measurements were done on GE Vivid S6. The severity of coronary artery disease is determined visually by an experienced operator with 5-year post fellowship experience, and lesions were assessed in two orthogonal views to conclude. Coronary artery disease severity was assessed by the Gensini Scoring system as this takes into account location, degree of stenosis, lesion length and even plaque morphology.

Data was archived and examined using SPSS v25.0. Quantitative variables like age, BMI, Waist to hip ratio, Gensini score and epicardial fat pad were expressed as mean and SD. Pearson's correlation test was used to determine the connection between epicardial fat thickness and the Gensini score. Qualitative variables like gender and co-morbidities (DM, HTN and Smoking) were measured as frequency and percentage. A Receiver Operating Characteristic examination was done to find the area under the curve to derive the EFT cut-off for determining the severity of CAD. A p-value ≤ 0.05 will be regarded as significant.

Results

The mean age of the participants was 55.94 ± 8.63 years, and the mean BMI was 23.95 ± 1.98 kg/m². The mean waist-to-hip ratio was 0.87 ± 0.02 .

A strong positive correlation was observed between EFT and the Gensini Score ($r = 0.749$, $p < 0.01$).

ROC analysis revealed an EFT cutoff of 0.450 cm for predicting CAD, with a sensitivity of 89.8% and an AUC of 0.920.

Table 1: Demographic of the study

	Minimum	Maximum	Mean	Standard Deviation
Age	31	69	55.94	8.627
BMI (kg/m ²)	17.48	27.57	23.9465	1.97781
Waist to Hip Ratio	.81	.9	.8696	.02293
Gensini Score	.0	120.0	52.739	28.4472
Epicardial Fat Thickness (mm)	2.00	10.02	6.37	1.59

n=113

Table 2: Correlation among EFT with age, waist-to-hip ratio and Gensini score

	Epicardial Thickness	Fat	N	Mean	Standard Deviation	Standard Error Mean	P value
BMI (kg/m ²)	>= 5.00 mm		98	24.0516	2.01825	.20387	.149
	< 5.00 mm		15	23.2593	1.57740	.40728	.096
Waist to Hip Ratio	>= 5.00 mm		98	.8729	.02178	.00220	.000
	< 5.00 mm		15	.8480	.01859	.00480	.000
Gensini Score	>= 5.00 mm		98	58.260	25.9350	2.6198	.000
	< 5.00 mm		15	16.667	14.3560	3.7067	.000
Age	>= 5.00 mm		98	56.26	8.270	.835	.320
	< 5.00 mm		15	53.87	10.783	2.784	.423

These findings highlight the potential link among EFT and both waist-to-hip ratio and Gensini score, indicating that individuals with higher waist-to-hip ratios and Gensini scores have increased epicardial fat thickness.

Table 3: Correlation of EFT with conventional risk factors of CAD

Variable	Category	EFT < 5.00 mm	EFT ≥ 5.00 mm	P value
Gender	Male	23	58	0.532
	Female	11	21	
DM	Yes	4	39	<0.001
	No	30	40	
HTN	Yes	8	27	0.262
	No	26	52	
Hyperlipidemias	Yes	12	52	0.003
	No	22	27	
Smoking	Yes	12	37	0.256
	No	22	42	

There was no statistically significant difference in EFT among genders, as indicated by the p-value of 0.532. In contrast, the variables of DM and hyperlipidemias demonstrated a significant association with EFT. Individuals with DM or hyperlipidemias exhibit higher EFT values compared to those without these conditions, as evidenced by the p-values of <0.001 and 0.003, respectively.

Table 4: Correlation of Gensini score with Epicardial fat thickness

Pearson's Correlation		Gensini Score	Epicardial Fat Thickness
Gensini Score	Pearson Correlation	1	.749**
	Sig. (2-tailed)		.000
	N	113	113
Epicardial Fat Thickness	Pearson Correlation	.749**	1
	Sig. (2-tailed)	.000	
	N	113	113

** . Correlation is significant at the 0.01 level (2-tailed).

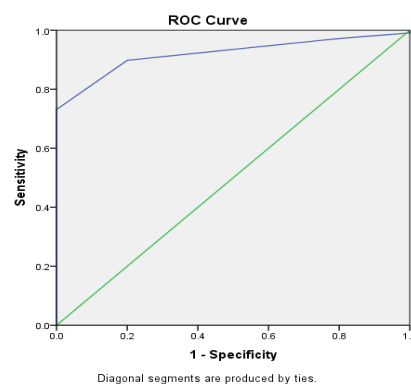


Figure 1: Receiver Operating Characteristic Curve

Gensini Score and EFT have a strong positive correlation. The Pearson correlation coefficient between the Gensini Score and EFT is 0.749. The p-value associated with this correlation is 0.000

Area Under the Curve

Test Result Variable(s): Epicardial Fat Thickness

Test Result Variable(s)	Area	Standard Error	Asymptotic Significance	95% Confidence Interval
Epicardial Fat Thickness	0.920	0.035	0.002	0.852 – 0.988

EFT cut-off for predicting CAD was 4.50 mm and had an accuracy of 89% and 1-precision of 20% (average under curve: 0.920, p value of 0.002).

Discussion

Over the last ten years, there has been enhanced awareness in studying EFT and epicardial fat volume as a novel risk indicator for atherosclerotic CAD.⁹ Researchers have focused on quantifying epicardial fat to enhance CAD risk prediction models, complementing traditional cardiovascular diagnostic methods such as the coronary artery calcium score. The EF thickness or volume measurements, along with coronary artery calcium scoring, have shown promise in enhancing the predictive value of the CAD risk model.¹⁰

Our study found an important positive relation between EFT and the Gensini Score, a measure of disease severity ($r = 0.749$, $p < 0.01$). Waist-to-Hip Ratio, a measure of central adiposity, also indicated a strong positive association with the Gensini Score ($r = 0.514$, $p < 0.01$).

The p-value of 0.532 indicates that there are no statistically significant variations in EFT among genders. This shows that gender may not significantly influence EFT. In contrast, the variables of DM and hyperlipidaemias demonstrated a significant association with EFT. Individuals with DM or hyperlipidaemias exhibit higher EFT values compared to those without these conditions, as evidenced by the p-values of <0.001 and 0.003, respectively. These findings suggest that individuals with DM or hyperlipidaemias may be at a higher risk of increased EFT. There was no important connection between EFT and HTN or smoking, as supported by p-values of 0.262 and 0.256, respectively. This implies that HTN or smoking may not have a substantial impact on EFT in the studied sample population.

Additional study is needed to gain a comprehensive recognition of the intricate roles of EAT in cardiovascular physiology and pathology. The Area Under the Curve for the test result variable "Epicardial Fat Thickness" was 0.920 with a standard error of 0.035. The asymptotic significance was 0.002, indicating a statistically significant relationship. The 95% confidence interval ranged from 0.852 to 0.988, suggesting a strong predictive ability for the test. EFT cut-off for predicting CAD was 4.50 mm and had a sensitivity of 89% and 1-specificity of 20% (area under curve: 0.920, p value of 0.002). At this cutoff, the sensitivity (true positive rate) was 89.8%, indicating a high ability to correctly identify individuals with the condition.

There are several limitations to consider in this study. To begin with, it's crucial to understand that the methodology used in the research does not allow for the identification of a causative link; rather, it simply permits the analysis of the connection between EFT and the seriousness of CAD. To investigate the underlying mechanisms and probable causality, more study is required. Another limitation is the assessment of EFT instead of volume. While volume measurements may provide more accurate results, they often require the use of computerized tomography scans, which involve radiation exposure. The choice to measure thickness instead of volume was likely made to minimize potential risks associated with radiation exposure. Moreover, the assessment of disease severity based on visually assessing the degree of stenosis has its limitations. Individual assessments may vary, leading to potential discrepancies in the determination of disease severity. It is important to consider inter-observer variability and the need for standardized assessment methods to ensure consistency and reliability in the evaluation of disease severity. When understanding, these limits should be considered the outcomes of the study and highlight the need for further research to address these limitations and provide a more comprehensive understanding of the relationship between EFT and CAD seriousness.

Conclusions

EFT is a promising non-invasive marker for assessing CAD severity. Its strong correlation with the Gensini Score and high sensitivity at the identified cutoff highlight its potential utility in clinical practice. Further large-scale, multicentre studies are warranted to validate these findings and explore the prognostic value of EFT in diverse populations.

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