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Original Article

Correlation between Epicardial Fat Thickness by Echocardiography with the Severity of Coronary Artery Disease: A Hospital-Based Observational Study Using Friesinger Score

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ABSTRACT

Background: Epicardial fat thickness (EFT) is a metabolically active visceral adipose tissue that is increasingly recognized as an important marker of cardiovascular risk and inflammation. Echocardiographic measurement of EFT is simple, non-invasive, reproducible and relatively inexpensive. However, evidence regarding the association between EFT and angiographic severity of coronary artery disease (CAD) remains limited in the Bangladeshi population. **Objective:** To evaluate the relationship between echocardiographically measured epicardial fat thickness and the angiographic severity of coronary artery disease assessed using the Friesinger score among patients with angiographically confirmed CAD. **Methods & Materials:** This observational cross-sectional study was conducted in the Department of Cardiology, 250 Bedded Mohammad Ali Hospital, Bogura, Bangladesh over a period of one year from January 2025 to December 2025. A total of 200 patients with confirmed CAD by coronary angiography were enrolled purposively. Demographic, anthropometric and clinical data were recorded. EFT was measured by transthoracic echocardiography from the parasternal long-axis view at end-systole over the right ventricular free wall. Coronary angiographic severity was assessed using the Friesinger score and patients were categorized into mild, moderate and severe CAD groups. **Results:** The mean age was 56.8±10.7 years and 72.0% of participants were male. Mean EFT was significantly greater in severe CAD than in moderate and mild CAD (8.1±1.3, 6.4±1.2 and 4.8±1.1 mm, respectively; $p<0.001$). EFT showed a strong positive correlation with Friesinger score ($r=0.712$, $p<0.001$). Diabetes, hypertension, smoking and obesity were significantly associated with increased EFT. Multivariate regression demonstrated that EFT was an independent predictor of severe CAD ($\beta=0.61$, $p<0.001$). **Conclusion:** Echocardiographic EFT is significantly associated with angiographic CAD severity and may provide a useful non-invasive marker for identifying patients at increased risk of severe CAD, particularly in resource-limited settings.

Keywords: *Epicardial fat thickness, Coronary artery disease, Friesinger score, Echocardiography, Atherosclerosis.*

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INTRODUCTION

Coronary artery disease (CAD) remains one of the leading causes of mortality and morbidity worldwide and is responsible for a substantial burden on healthcare systems, particularly in developing countries like Bangladesh. The prevalence of CAD has risen dramatically over the last few decades due to rapid urbanization, unhealthy dietary habits, sedentary lifestyle, smoking, obesity, diabetes mellitus, hypertension and dyslipidemia. Despite remarkable advances in diagnostic and therapeutic interventions, CAD continues to be a major contributor to cardiovascular deaths globally. Early identification of patients at higher risk for severe coronary artery disease is therefore essential for improving prognosis and reducing adverse cardiovascular outcomes.[1] Atherosclerosis is a chronic inflammatory process involving lipid accumulation, endothelial dysfunction and vascular inflammation within the coronary arteries. Recently, increasing attention has been focused on visceral adipose tissue and its role in cardiovascular disease pathogenesis. Epicardial adipose tissue (EAT), also known as epicardial fat, is a metabolically active visceral fat depot located between the myocardium and the visceral pericardium. Unlike subcutaneous adipose tissue, epicardial fat shares a common embryological origin and microcirculation with the myocardium and coronary arteries.[2] Epicardial adipose tissue has been recognized as an endocrine and paracrine organ capable of secreting numerous bioactive substances, including inflammatory cytokines, adipokines, free fatty acids and chemokines. Increased epicardial fat accumulation may contribute to endothelial dysfunction, oxidative stress, plaque instability and progression of coronary atherosclerosis through local inflammatory effects on adjacent coronary vessels.[3] Due to the absence of a fascial layer between epicardial fat and coronary arteries, inflammatory mediators may directly influence the coronary vasculature and accelerate the development of coronary artery disease.[4] Epicardial fat thickness (EFT) can be measured by several imaging modalities including echocardiography, computed tomography (CT) and magnetic resonance imaging (MRI). Among these methods, transthoracic echocardiography is widely used because it is inexpensive, non-invasive, radiation-free, reproducible and easily available in routine clinical practice. Echocardiographic measurement of EFT is usually performed from the parasternal long-axis view over the free wall of the right ventricle. Several studies have demonstrated that increased EFT is associated with metabolic syndrome, obesity, hypertension, diabetes mellitus and coronary artery disease.[5] Different angiographic scoring systems are used to assess the severity and extent of coronary artery disease. Among these, the Friesinger score is a simple and practical angiographic scoring system that evaluates the three major coronary arteries separately according to the degree and distribution of stenosis. The total score ranges from 0 to 15 with higher scores indicating more severe and diffuse coronary artery disease. Friesinger score has been used extensively for objective assessment of CAD severity in clinical and research settings.[6] Several previous studies have reported significant

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associations between epicardial fat thickness and angiographic severity of coronary artery disease. Iacobellis et al. demonstrated that echocardiographic EFT was significantly associated with angiographically proven CAD severity.[7] Rostamzadeh et al. also observed a strong positive correlation between EFT and SYNTAX score among patients undergoing coronary angiography.[8] Similarly, Sinha et al. reported that increased EFT was significantly associated with higher Gensini score and multivessel coronary artery disease.[9] Recent evidence suggests that epicardial fat may also serve as an independent predictor of adverse cardiovascular outcomes including myocardial infarction, ischemia, atrial fibrillation and heart failure.[10] Furthermore, increased epicardial fat has been associated with inflammatory biomarkers and insulin resistance, supporting its role in systemic cardiometabolic dysfunction.[11]Despite growing international evidence regarding the clinical significance of epicardial fat thickness, there is limited data from Bangladesh evaluating the relationship between EFT and severity of coronary artery disease. Moreover, most previous studies utilized SYNTAX or Gensini scoring systems, while relatively few studies assessed CAD severity using the Friesinger score. Considering the increasing burden of CAD and the need for simple non-invasive markers for risk stratification, the present study was undertaken to evaluate the correlation between epicardial fat thickness measured by echocardiography and severity of coronary artery disease assessed by Friesinger score among patients with angiographically confirmed CAD.

METHODS & MATERIALS

Study Design and Setting

This hospital-based observational cross-sectional study was conducted in the Department of Cardiology at 250 Bedded Mohammad Ali Hospital, Bogura, Bangladesh over a period of one year from January 2025 to December 2025.

Study Population

The study population consisted of patients diagnosed with coronary artery disease by coronary angiography who were admitted or attended the cardiology department during the study period.

Sample Size

A total of 200 patients were included purposively according to inclusion and exclusion criteria.

Inclusion Criteria

- Patients aged ≥18 years
- Angiographically confirmed coronary artery disease
- Patients willing to provide informed written consent

Exclusion Criteria

- Previous coronary artery bypass graft surgery
- Congenital heart disease
- Significant valvular heart disease
- Pericardial disease
- Cardiomyopathy
- Severe renal or hepatic failure
- Poor echocardiographic window

Data Collection Procedure

Detailed history regarding demographic variables, smoking status, hypertension, diabetes mellitus, dyslipidemia, family history of CAD and anthropometric measurements was obtained using a questionnaire. Blood pressure, body mass index (BMI), fasting blood glucose and lipid profile were recorded.

Echocardiographic Assessment

Transthoracic echocardiography was performed using a standard echocardiography machine by experienced cardiologists. Epicardial fat thickness was measured from the parasternal long-axis view at end-systole over the free wall of the right ventricle. The average of three cardiac cycles was recorded. EFT was identified as the echo-free space between the outer wall of myocardium and visceral pericardium.

Coronary Angiography and Friesinger Score

Coronary angiography was performed using standard Judkins technique. Severity of CAD was assessed using the Friesinger scoring system. Each major coronary artery was assigned a score from 0 to 5:

- 0 = no abnormality
- 1 = trivial irregularities
- 2 = localized 29% stenosis
- 3 = multiple 30–68% stenosis
- 4 = 69–100% stenosis without proximal involvement
- 5 = total occlusion/proximal severe lesion

Total Friesinger score ranged from 0 to 15. Patients were categorized as:

- Mild CAD: Score 0–4
- Moderate CAD: Score 5–9
- Severe CAD: Score 10–15

Statistical Analysis

Data were analyzed using SPSS version 26. Quantitative variables were expressed as mean ± standard deviation, whereas categorical variables were expressed as frequency and percentage. ANOVA, Chi-square test, Pearson correlation and multivariate linear regression analyses were performed. A p-value <0.05 was considered statistically significant.

RESULTS

Among the 200 patients enrolled in the study, the highest proportion of patients belonged to the age group of 51–60 years (39.0%), followed by ≤50 years (31.0%) and >60 years (30.0%). The mean age of the participants was 56.8±10.7 years. Male patients constituted the majority of the study population (72.0%), whereas females accounted for 28.0% (*Table I*).

Table I

Socio-demographic and Clinical Characteristics of the Study Participants (*n*=200).

Variables	Frequency (n)	Percentage (%)
Age Group (years)		
≤50 years	62	31.0
51–60 years	78	39.0
>60 years	60	30.0
Gender		
Male	144	72.0
Female	56	28.0
Risk Factors		
Hypertension	126	63.0
Diabetes Mellitus	98	49.0
Smoking	92	46.0
Dyslipidemia	108	54.0
Obesity (BMI ≥30 kg/m²)	52	26.0

Regarding cardiovascular risk factors, hypertension was the most common comorbidity present in 63.0% of patients, followed by dyslipidemia (54.0%), diabetes mellitus (49.0%) and smoking (46.0%). Obesity was observed in 26.0% of the participants. These findings indicate a high prevalence of conventional cardiovascular risk factors among patients with coronary artery disease.

Table II demonstrates the distribution of patients according to the severity of coronary artery disease assessed by Friesinger score. Among the study participants, the majority of patients belonged to the moderate CAD group accounting for 43.0% of cases. Severe CAD was observed in 33.0% of patients, while mild CAD constituted 24.0% of the study population. The findings suggest that a substantial proportion of the patients undergoing coronary angiography had moderate to severe coronary artery disease, reflecting significant atherosclerotic burden among the study participants.

Table II
Distribution of Patients According to Severity of Coronary Artery Disease by Friesinger Score (*n*=200).

Severity Category	Friesinger Score	Frequency (n)	Percentage (%)
Mild CAD	0–4	48	24.0
Moderate CAD	5–9	86	43.0
Severe CAD	10–15	66	33.0

Table III the comparison of mean epicardial fat thickness among different severity groups of coronary artery disease. Patients with mild CAD had a mean EFT of 4.8±1.1 mm, whereas patients with moderate CAD demonstrated a higher mean EFT of 6.4±1.2 mm. The highest mean epicardial fat thickness was observed among patients with severe CAD (8.1±1.3 mm). Statistical analysis revealed a highly significant association between increasing epicardial fat thickness and severity of coronary artery disease ($p<0.001$). The findings indicate that epicardial fat thickness progressively increases with greater angiographic severity of CAD.

Table III
Comparison of Mean Epicardial Fat Thickness According to Severity of CAD.

Severity Group	Number of Patients	Mean EFT (mm)	SD	p-value
Mild CAD	48	4.8	1.1	
Moderate CAD	86	6.4	1.2	
Severe CAD	66	8.1	1.3	<0.001

Table IV shows the correlation analysis between epicardial fat thickness and Friesinger score among the study participants. A strong positive correlation was observed between EFT and Friesinger score ($r=0.712$), which was statistically highly significant ($p<0.001$) ($r=0.712$). This finding indicates that patients with higher epicardial fat thickness tend to have more severe coronary artery disease. The result supports the hypothesis that increased epicardial adiposity is associated with greater coronary atherosclerotic burden.

Table IV
Correlation between Epicardial Fat Thickness and Friesinger Score.

Variables	Correlation Coefficient (r)	p-value
Epicardial Fat Thickness vs Friesinger Score	0.712	<0.001

Table V presents the association between conventional cardiovascular risk factors and epicardial fat thickness. Patients with diabetes mellitus had significantly higher mean EFT (7.2±1.4 mm) compared to non-diabetic patients. Similarly, hypertension, smoking, dyslipidemia and obesity were significantly associated with increased epicardial fat thickness. The highest mean EFT was observed among obese patients (7.5±1.7 mm), followed by diabetic patients. All associations were statistically significant, indicating that epicardial fat accumulation is closely related to established cardiometabolic risk factors.

Table V
Association of Clinical Risk Factors with Mean Epicardial Fat Thickness.

Risk Factors	Mean EFT (mm)	SD	p-value
Diabetes Mellitus	7.2	1.4	<0.001
Hypertension	6.8	1.5	0.002
Smoking	6.9	1.6	0.001
Dyslipidemia	6.7	1.3	0.004
Obesity	7.5	1.7	<0.001

Table VI demonstrates the multivariate regression analysis performed to identify independent predictors of severe coronary artery disease. Epicardial fat thickness emerged as the strongest independent predictor of severe CAD with a β coefficient of 0.61, which was highly statistically significant ($p<0.001$). Additionally, diabetes mellitus, hypertension, smoking and obesity also showed significant independent associations with severe coronary artery disease. These findings indicate that increased epicardial fat thickness independently contributes to the severity of coronary artery disease even after adjustment for traditional cardiovascular risk factors.

Table VI
Multivariate Regression Analysis for Predictors of Severe Coronary Artery Disease.

Variables	β Coefficient	Standard Error	p-value
Epicardial Fat Thickness	0.61	0.08	<0.001
Diabetes Mellitus	0.24	0.07	0.003
Hypertension	0.19	0.06	0.011
Smoking	0.17	0.05	0.018
Obesity	0.21	0.07	0.007

DISCUSSION

The present hospital-based observational study evaluated the relationship between epicardial fat thickness measured by transthoracic echocardiography and severity of coronary artery disease assessed by Friesinger score among patients with angiographically confirmed CAD. The findings of the study demonstrated a significant positive correlation between epicardial fat thickness and severity of coronary artery disease. In this study, the mean age of the participants was 56.8±10.7 years and the majority of patients were male (72.0%). Similar demographic characteristics were observed in previous studies evaluating epicardial fat thickness and coronary artery disease severity. Rostamzadeh et al. reported a mean patient age of approximately 58 years with male predominance among CAD patients.[8] Male predominance in CAD may be explained by greater exposure to cardiovascular risk factors such as smoking, occupational stress and metabolic abnormalities.[12]Traditional cardiovascular risk factors including hypertension, diabetes mellitus, smoking, dyslipidemia and obesity were highly prevalent among the study participants. Hypertension was observed in 63.0% of patients, while diabetes mellitus was present in 49.0% of cases. Similar findings have been reported in South Asian populations where cardiometabolic risk factors contribute substantially to coronary artery disease burden.[13] One of the major findings of the present study was that epicardial fat thickness progressively increased with increasing severity of coronary artery disease. Patients with severe CAD had significantly higher mean EFT compared to patients with moderate and mild disease. This observation is consistent with findings from Iacobellis et al., who first demonstrated that epicardial adipose tissue thickness measured by echocardiography was significantly associated with angiographic severity of coronary artery disease.[7] The present study also revealed a strong positive correlation between epicardial fat thickness and Friesinger score ($r=0.712$, $p<0.001$). Similar positive correlations between EFT and angiographic severity scores have been reported by several previous investigators. Sinha et al. observed that patients with higher Gensini scores had significantly increased epicardial fat thickness.[9] Likewise, Rostamzadeh et al. found a strong association between EFT and SYNTAX score among patients undergoing coronary angiography.[8] The association between epicardial fat and coronary artery disease may be explained by several pathophysiological mechanisms. Epicardial adipose tissue is metabolically active and secretes various inflammatory mediators including tumor necrosis factor-alpha, interleukin-6, resistin and monocyte chemoattractant protein-1. These inflammatory cytokines may promote endothelial dysfunction, oxidative stress, plaque instability and progression of coronary atherosclerosis.[14] Because epicardial fat is anatomically adjacent to coronary arteries without a separating fascial layer, these inflammatory substances may exert direct local effects on the coronary vasculature.[15] Another important finding of the present study was the significant association of increased epicardial fat thickness with diabetes mellitus, hypertension, smoking, dyslipidemia and obesity. Obese patients demonstrated the highest mean EFT values among the risk factor groups. Similar findings were reported by Mahabadi et al., who demonstrated strong associations between epicardial adipose tissue and obesity, metabolic syndrome and cardiovascular risk factors.[16] Akhter et al. also reported significantly increased EFT among diabetic patients with coronary artery disease.[17] Multivariate regression analysis in the current study identified epicardial fat thickness as an independent predictor of severe coronary artery disease even after adjustment for traditional cardiovascular risk factors. This finding supports the growing evidence that epicardial fat is not merely a marker of generalized obesity but may independently contribute to coronary atherosclerosis. Similar observations were reported by Jeong et al., who identified EFT as an independent determinant of coronary artery disease severity.[18] The use of Friesinger score in this study provided a simple and practical assessment of coronary artery disease severity. Compared to more complex angiographic scoring systems, Friesinger score is relatively straightforward and reproducible for routine clinical use. The present study therefore contributes additional evidence regarding the usefulness of epicardial fat thickness in predicting CAD severity specifically using Friesinger score. Echocardiographic assessment of epicardial fat thickness offers several clinical advantages. It is inexpensive, radiation-free, widely available and easy to perform in routine cardiology practice. In resource-limited settings such as Bangladesh, EFT measurement may serve as a valuable non-invasive tool for identifying high-risk CAD patients and improving cardiovascular risk stratification. [19] The study has certain limitations. Being a single-center cross-sectional study, causal relationship could not be established. The sample size was relatively limited and echocardiographic measurement may have observer variability. Furthermore, advanced imaging modalities such as cardiac CT or MRI were not used for comparison. Nevertheless, the study findings provide important insight regarding the relationship between epicardial fat thickness and severity of coronary artery disease in Bangladeshi patients. Overall, the present study demonstrated that increased epicardial fat thickness is significantly associated with greater angiographic severity of coronary artery disease and may serve as an independent non-invasive predictor of severe CAD.

CONCLUSION

Epicardial fat thickness measured by transthoracic echocardiography showed a significant positive correlation with severity of coronary artery disease assessed by Friesinger score. Increased EFT was associated with higher angiographic disease burden and conventional cardiovascular risk factors. Echocardiographic assessment of EFT may serve as a simple, non-invasive, inexpensive and clinically useful marker for risk stratification of coronary artery disease, especially in resource-constrained healthcare settings. Further multicenter prospective studies with larger sample sizes are recommended to validate these findings and establish standardized EFT cutoff values for predicting severe coronary artery disease.

DECLARATIONS

Ethical approval for this study was obtained from the Institutional Ethical Review Committee of 250 Bedded Mohammad Ali Hospital, Bogura, Bangladesh. The study was conducted in

accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all participants before enrollment in the study.

CONSENT FOR PUBLICATION

Not applicable. No, individually identifiable patient information, images or other identifying details are presented in this manuscript.

AVAILABILITY OF DATA AND MATERIALS

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request, subject to institutional and ethical restrictions.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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AUTHORS CONTRIBUTIONS

All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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