

ASSOCIATION OF INTERATRIAL SEPTAL THICKNESS BY CONVENTIONAL 2D ECHOCARDIOGRAPHY WITH ANGIOGRAPHIC SEVERITY OF CORONARY ARTERY DISEASE

Cardiology

Dr. Sateesh Reddy*	Department of Cardiology, Kalinga Institute of Medical Sciences (KIMS), KIIT, Bhubaneswar, Odisha, India*Corresponding Author
Dr. Anupam Jena	Department of Cardiology, Kalinga Institute of Medical Sciences (KIMS), KIIT, Bhubaneswar, Odisha, India
Dr. Panchanan Sahoo	Department of Cardiology, Kalinga Institute of Medical Sciences (KIMS), KIIT, Bhubaneswar, Odisha, India
Dr. Binayananda Padhee	Department of Cardiology, Kalinga Institute of Medical Sciences (KIMS), KIIT, Bhubaneswar, Odisha, India
Dr. Suryakant Jena	Department of Cardiology, Kalinga Institute of Medical Sciences (KIMS), KIIT, Bhubaneswar, Odisha, India
Dr. Subasis Mishra	Department of Cardiology, Kalinga Institute of Medical Sciences (KIMS), KIIT, Bhubaneswar, Odisha, India
Dr. Teeda Poojitha	Department of Cardiology, Kalinga Institute of Medical Sciences (KIMS), KIIT, Bhubaneswar, Odisha, India
Dr. Rahul Jindal	Department of Cardiology, Kalinga Institute of Medical Sciences (KIMS), KIIT, Bhubaneswar, Odisha, India
Dr. Raghavendra Shridhar	Department of Cardiology, Kalinga Institute of Medical Sciences (KIMS), KIIT, Bhubaneswar, Odisha, India

ABSTRACT

Background: Interatrial septal thickness (IAST) is a readily measurable echocardiographic parameter that may reflect the burden of coronary artery disease (CAD). This study evaluated the association between IAST measured by conventional two-dimensional echocardiography and angiographic severity of CAD. **Methods:** This hospital-based prospective observational study with a cross-sectional design included 220 consecutive patients undergoing coronary angiography. IAST was measured by conventional 2D transthoracic echocardiography in the subcostal coronal view at end-diastole. Coronary disease severity was assessed using the number of involved vessels and the SYNTAX score. Associations were evaluated using Spearman's correlation and chi-square tests. Binary logistic regression was performed to identify factors associated with increased IAST (>10 mm). **Results:** The median age was 67 years (IQR, 54–72), and 70.0% were male. Median IAST was 7.9 mm (IQR, 6.8–8.7), with IAST >10 mm in 15.9% of patients. The median SYNTAX score was 21.3 (IQR, 13.6–29.6). IAST showed a significant positive correlation with SYNTAX score ($p=0.565$, $p<0.001$). IAST >10 mm was present in 3.4% of patients with low SYNTAX scores compared with 70.7% of those with high scores, and in 3.4%, 3.1%, and 76.3% of patients with mild, moderate, and severe CAD, respectively ($p<0.001$). On multivariable analysis, high SYNTAX score, severe CAD, triple-vessel disease, and reduced left ventricular systolic function were significantly associated with IAST >10 mm. **Conclusion:** Increased IAST measured by conventional 2D echocardiography was significantly associated with greater angiographic severity and complexity of CAD. IAST may serve as a simple, non-invasive echocardiographic marker of increased coronary disease burden, warranting further prospective validation.

KEYWORDS

Interatrial Septal Thickness; Coronary Artery Disease; Transthoracic Echocardiography; SYNTAX Score; Coronary Angiography; Multivessel Coronary Disease; Echocardiographic Marker

INTRODUCTION:

Coronary artery disease (CAD) remains a major contributor to cardiovascular morbidity and mortality, particularly in populations undergoing evaluation for suspected ischaemic heart disease. [1,2] Its clinical significance depends not only on the presence of coronary atherosclerosis but also on its anatomical distribution and complexity, which influence treatment planning and prognosis. [3,4] Although conventional cardiovascular risk factors help identify individuals at increased risk, they do not directly establish the extent of coronary arterial involvement. Coronary angiography provides anatomical assessment, and scoring systems such as the Gensini score and SYNTAX score offer structured approaches to grading disease burden and complexity. [5,6] However, angiography is invasive, creating an interest in echocardiographic parameters that might provide additional information before or alongside invasive assessment. [3,7] Interatrial septal thickness (IAST) is a structural measurement obtainable during transthoracic echocardiography. Previous investigations have explored its relationship with coronary artery disease and angiographic measures of disease severity, including the Gensini and SYNTAX scores. [8–11] Nevertheless, the available evidence is limited, and the strength of the reported associations may vary across study populations and assessment methods. Further evaluation using conventional two-dimensional echocardiography may help clarify

whether IAST is associated with the anatomical extent and complexity of CAD. Accordingly, the present study investigated the relationship between echocardiographically measured IAST and angiographic disease severity, assessed by SYNTAX score and the number of involved coronary vessels.

Materials and Methods:

This hospital-based observational study was conducted in the Department of Cardiology at Pradyumna Bal Memorial Hospital, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, between July 2024 and April 2026. Adults aged over 18 years who presented to the outpatient department, inpatient services, Emergency Department or Cardiac Intensive Care Unit with clinical features suggestive of CAD and underwent coronary angiography were assessed for eligibility. Patients with cardiomyopathies, chronic kidney disease, active oncological disease, pregnancy or intellectual disability, as specified in the study protocol, were excluded. Eligible patients were recruited consecutively until the planned sample of 220 participants was obtained.

Sampling:

The sample size was calculated using the formula for estimation of sample size in correlation studies. Assuming a two-sided 95%

confidence level, 80% study power, and an anticipated correlation coefficient of 0.20 based on previous literature, the minimum required sample size was calculated to be 194 participants [12]. Considering the possibility of incomplete data and attrition, an additional 10–15% of participants were planned for recruitment, and the final sample size was rounded to 220 participants.

Eligible participants were enrolled using convenience sampling. All patients fulfilling the eligibility criteria and presenting to the Cardiology outpatient department, inpatient department, Emergency Department, and Cardiac Intensive Care Unit during the study period were consecutively recruited. A total of 220 participants were included in the final analysis.

Data Collection, Study Tools and Parameters used:

After obtaining written informed consent, detailed demographic and clinical information was recorded using a predesigned structured case record form. Demographic variables included age and sex. Clinical assessment included presenting symptoms and signs suggestive of CAD, history of hypertension, diabetes mellitus, smoking, dyslipidaemia, body mass index (BMI), heart rate, and blood pressure. Routine laboratory investigations included complete haemogram, renal function tests, HbA1c, lipid profile, thyroid function tests, cardiac troponin-I, and urine routine examination. Standard 12-lead electrocardiography was performed for assessment of rhythm abnormalities and electrocardiographic changes suggestive of myocardial ischaemia.

Transthoracic echocardiography was performed in all participants using a Philips EPIQ 7™ system equipped with an X5 transducer. IAST was assessed in the subcostal coronal view, with the measurement taken perpendicular to the interatrial septum, inferior to the fossa ovalis, at end-diastole. Three consecutive cardiac cycles were measured, and their mean was used in the analysis. Left ventricular ejection fraction (LVEF) was recorded to characterise systolic function.

Coronary angiography was performed using the SIEMENS ARTIS PURE catheterization laboratory system. Quantitative angiographic assessment was performed using the CMS system (MEDIS, Leiden, Netherlands). The extent and severity of CAD were assessed according to the number of involved epicardial coronary vessels and the SYNTAX score.

The SYNTAX score was used to quantify the anatomical extent and complexity of coronary artery disease. Coronary lesions producing ≥50% diameter stenosis in vessels ≥1.5 mm in diameter were considered for scoring. The score incorporated lesion characteristics including the number and location of lesions, coronary dominance, total occlusion, bifurcation and trifurcation lesions, aorto-ostial involvement, severe tortuosity, lesion length >20 mm, heavy calcification, thrombus, and diffuse disease or small-vessel involvement. Participants were categorized into low (≤22), intermediate (23–32), and high (≥33) SYNTAX score groups [13,14]. Coronary vessel involvement was assessed according to significant stenosis involving the major epicardial coronary arteries, namely the left anterior descending, left circumflex, and right coronary arteries. Patients were categorized as having single-vessel disease (SVD), double-vessel disease (DVD), or triple-vessel disease (TVD). Significant coronary artery disease was defined as ≥50% luminal diameter stenosis.

The primary study variable was interatrial septal thickness measured by conventional two-dimensional transthoracic echocardiography. The outcome variable was angiographic severity of coronary artery disease, assessed using the SYNTAX score and extent of coronary vessel involvement.

Data Analysis:

Statistical analyses were conducted using IBM SPSS Statistics, version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarised using means and standard deviations or medians and interquartile ranges, depending on their distributions. Categorical data were reported as counts and percentages. Associations between categorical variables were examined using Pearson's chi-square test, and Spearman's rank correlation coefficient was used to evaluate relationships involving IAST. Binary logistic regression was used to investigate factors associated with IAST greater than 10 mm. Adjusted

odds ratios with 95% confidence intervals were reported. Model performance was evaluated using the Hosmer–Lemeshow goodness-of-fit test and Nagelkerke R². Statistical significance was defined as a two-sided p-value below 0.05.

Ethical Approval:

The study was initiated after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrolment. Participation was voluntary, and confidentiality of participant information was maintained throughout the study. Unique identification codes were used to ensure anonymity.

Results:

Baseline characteristics:

A total of 220 patients with coronary artery disease undergoing coronary angiography were included in the study. The median age was 67 years (IQR, 54–72), with 154 (70.0%) participants being male. Smoking was reported in 43.2% of participants, while diabetes mellitus, hypertension, and dyslipidaemia were present in 44.5%, 52.7%, and 53.2%, respectively. The median BMI was 27.8 kg/m² (IQR, 24.6–30.5). The baseline demographic, clinical, echocardiographic, and angiographic characteristics of the study population are presented in Table 1.

The median IAST was 7.9 mm (IQR, 6.8–8.7), ranging from 2.8 to 12.9 mm. IAST was <8 mm in 110 (50.0%) patients, 8–10 mm in 75 (34.1%), and >10 mm in 35 (15.9%). Most patients had preserved LV systolic function (74.5%), whereas mild and moderate LV systolic dysfunction were present in 16.4% and 9.1%, respectively.

The median SYNTAX score was 21.3 (IQR, 13.6–29.6), with 117 (53.2%) patients having a low score (≤22), 62 (28.2%) an intermediate score (23–32), and 41 (18.6%) a high score (≥33). Double-vessel disease was the most frequent angiographic pattern, occurring in 117 (53.2%) patients, followed by single-vessel disease in 65 (29.5%) and triple-vessel disease in 38 (17.3%).

Table 1: Baseline characteristics of the study participants (N=220)

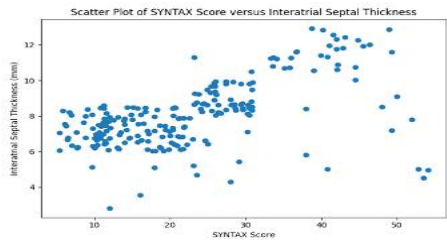
Variables	Number (Percentage), Median [IQR (25-75)]
Age, years	67 (54–72)
Male sex	154 (70.0)
BMI, kg/m ²	27.8 (24.6–30.5)
Smoking	95 (43.2)
Diabetes mellitus	98 (44.5)
Hypertension	116 (52.7)
Dyslipidaemia	117 (53.2)
IAST, mm	7.9 (6.8–8.7)
IAST >10 mm	35 (15.9)
LVEF ≥50%	164 (74.5)
LVEF 41–49%	36 (16.4)
LVEF 30–40%	20 (9.1)
SYNTAX score	21.3 (13.6–29.6)
SYNTAX ≤22	117 (53.2)
SYNTAX 23–32	62 (28.2)
SYNTAX ≥33	41 (18.6)
Single-vessel disease	65 (29.5)
Double-vessel disease	117 (53.2)
Triple-vessel disease	38 (17.3)

Association of IAST with angiographic severity:

IAST demonstrated a significant positive correlation with SYNTAX score (Spearman's $\rho=0.565$, $p<0.001$), with greater septal thickness observed with increasing angiographic complexity (Figure 1).

A significant association was observed between IAST and LV systolic function ($\chi^2=100.38$, $p<0.001$). IAST >10 mm was present in 4.3% of patients with preserved LV systolic function, compared with 33.3% of those with mild and 80.0% of those with moderate LV systolic dysfunction.

Figure 1: Scatter Plot Demonstrating the Correlation Between SYNTAX Score and Interatrial Septal Thickness Among Study Participants (N=220)



Similarly, IAST was strongly associated with angiographic disease severity. IAST >10 mm was present in 3.4% of patients with low SYNTAX scores compared with 70.7% of those with high SYNTAX scores ($p<0.001$). IAST >10 mm was also observed in 3.4% of patients with mild CAD, 3.1% with moderate CAD, and 76.3% with severe CAD ($p<0.001$). A similar pattern was observed across vessel involvement, with IAST >10 mm present in 3.4%, 3.1%, and 76.3% of patients with single-, double-, and triple-vessel disease, respectively ($p<0.001$).

Independent predictors of increased IAST:

On multivariable logistic regression, reduced LV systolic function, higher SYNTAX score, greater CAD severity, and increasing vessel involvement were independently associated with IAST >10 mm. Compared with preserved LV systolic function, mild and moderate LV systolic dysfunction were associated with adjusted ORs of 5.10 (95% CI, 1.84–14.13; $p=0.002$) and 22.65 (95% CI, 6.03–85.08; $p<0.001$), respectively.

Compared with a low SYNTAX score, intermediate and high scores were associated with adjusted ORs of 3.64 (95% CI, 1.08–12.22; $p=0.037$) and 59.18 (95% CI, 16.95–206.62; $p<0.001$), respectively. Severe CAD was associated with an adjusted OR of 69.31 (95% CI, 18.43–260.56; $p<0.001$), while triple-vessel disease was associated with an adjusted OR of 70.71 (95% CI, 18.71–267.24; $p<0.001$). The complete multivariable analysis is presented in Table 2.

The regression model was statistically significant ($\chi^2=148.6$, $p<0.001$), explained 68% of the variance (Nagelkerke $R^2=0.68$), and demonstrated satisfactory goodness of fit (Hosmer–Lemeshow $p=0.53$).

Table 2: Binary Logistic Regression Analysis for Predictors of Increased Interatrial Septal Thickness (>10 mm) (N=220)

Cardiovascular Severity Parameters	β coefficient	Adjusted OR	95% CI	p-value
Left Ventricular Ejection Fraction				
≥50% (Reference)	–	1.00	–	–
41–49% [Mild dysfunction]	1.63	5.10	1.84–14.13	0.002
30–40% [Moderate dysfunction]	3.12	22.65	6.03–85.08	<0.001
SYNTAX score				
≤22 [Low] (Reference)	–	1.00	–	–
23–32 [Intermediate]	1.29	3.64	1.08–12.22	0.037
≥33 [High]	4.08	59.18	16.95–206.62	<0.001
Severity				
Mild (Reference)	–	1.00	–	–
Moderate	1.42	4.13	1.18–14.43	0.026
Severe	4.24	69.31	18.43–260.56	<0.001
CAG findings/Vessel score				
Single vessel disease (Reference)	–	1.00	–	–
Double vessel disease	1.42	4.15	1.19–14.51	0.025
Triple vessel disease	4.26	70.71	18.71–267.24	<0.001
Model $\chi^2 = 148.6$ Nagelkerke $R^2 = 0.68$ Hosmer–Lemeshow test $p = 0.53$ Overall model significance: $p < 0.001$				

DISCUSSION:
In this cohort of 220 patients undergoing coronary angiography, greater interatrial septal thickness was associated with more extensive and complex coronary artery disease. The correlation between IAST and the SYNTAX score was positive and of moderate magnitude (Spearman's $\rho = 0.565$; $p < 0.001$). Furthermore, septal thickness exceeding 10 mm was more frequently observed among patients with high SYNTAX scores, severe CAD and triple-vessel involvement.

Our findings are consistent with the study by Chaowalit et al., which demonstrated an independent association between atrial septal thickness and the presence and extent of CAD after adjustment for conventional risk factors [15]. Reddy et al. subsequently reported a strong positive correlation between IAST and CAD severity ($r=0.868$) in 200 patients [10]. Although the correlation in our study was less pronounced, the direction of association was similar, supporting the reproducibility of this relationship across different populations.

Similarly, Chakraborty et al. reported a moderate correlation between IAST and Gensini score ($r=0.58$), with increased IAST independently associated with severe CAD [16]. The comparable correlation observed in our study using the SYNTAX score ($p=0.565$) suggests that the relationship between IAST and coronary disease burden is not restricted to a particular angiographic scoring system. More recently, Jesrani et al. demonstrated a significant correlation between IAST and SYNTAX score ($p=0.62$) in patients with myocardial infarction, with greater IAST among those with triple-vessel or left-main/multivessel disease [11]. Our findings are closely concordant, while extending this association to a broader angiographic population.

The biological basis for this association may relate to cardiac adiposity. The interatrial septum contains adipose tissue and may reflect the overall burden of cardiac adipose tissue, which has been implicated in inflammation, endothelial dysfunction, and atherosclerosis [11,16]. However, interatrial septal thickness is also influenced by age and body size, as demonstrated by Agmon et al., highlighting the importance of accounting for potential confounding factors [17].

In the present study, IAST >10 mm was strongly associated with high SYNTAX score, severe CAD, and triple-vessel disease on multivariable analysis. The magnitude of these associations was greater than that reported by Chakraborty et al [16]. However, the differing study populations, outcome definitions, and regression models limit direct comparison of effect estimates. Furthermore, the cross-sectional design precludes establishing causality.

Overall, our findings, together with previous evidence, indicate that IAST may represent a readily measurable echocardiographic marker of advanced CAD and coronary anatomical complexity [10,11,15,16]. Prospective multicentre studies are required to establish standardized IAST cut-offs and determine whether its addition to conventional risk assessment provides meaningful incremental diagnostic or prognostic value.

CONCLUSION:
In this study, interatrial septal thickness measured by conventional two-dimensional transthoracic echocardiography was positively associated with the angiographic severity and complexity of coronary artery disease. Values exceeding 10 mm were more common among patients with high SYNTAX scores, severe CAD and triple-vessel involvement. These findings support further investigation of IAST as a potential adjunctive echocardiographic marker of coronary disease burden. Prospective multicentre studies are needed to validate measurement thresholds and establish its additional clinical value.

REFERENCES:

- Roth GA, Mensah GA, Johnson CO, Addolorato G, Ammirati E, Baddour LM, et al. Global Burden of Cardiovascular Diseases and Risk Factors, 1990–2019. *Journal of the American College of Cardiology*. 2020 Dec;76(25):2982–3021. doi:10.1016/j.jacc.2020.11.010
- World Health Organization. Cardiovascular diseases (CVDs) [Internet]. Geneva: World Health Organization; 2025.
- Vrints C, Andreotti F, Koskinas KC, Rossello X, Adamo M, Ainslie J, et al.; ESC Scientific Document Group. 2024 ESC Guidelines for the management of chronic coronary syndromes. *Eur Heart J*. 2024;45(36):3415–3537. doi:10.1093/eurheartj/ehae177. Erratum in: *Eur Heart J*. 2025;46(16):1565. doi:10.1093/eurheartj/ehaf079.
- Neumann FJ, Sousa-Uva M, Ahlsson A, Alfonso F, Banning AP, Benedetto U, et al.; ESC Scientific Document Group. 2018 ESC/EACTS Guidelines on myocardial revascularization. *Eur Heart J*. 2019;40(2):87–165. doi:10.1093/eurheartj/ehy394. Erratum in: *Eur Heart J*. 2019;40(37):3096. doi:10.1093/eurheartj/ehz507.

5. Gensini GG. A more meaningful scoring system for determining the severity of coronary heart disease. *Am J Cardiol.* 1983;51(3):606. doi:10.1016/S0002-9149(83)80105-2.
6. Neumann FJ, Sousa-Uva M, Ahlsson A, Alfonso F, Banning AP, Benedetto U, Byrne RA, Collet JP, Falk V, Head SJ, et al. 2018 ESC/EACTS Guidelines on myocardial revascularization. *Eur Heart J.* 2019;40(2):87-165. doi:10.1093/eurheartj/ehy394.
7. Mitchell C, Rahko PS, Blauwet LA, Canaday B, Finstuen JA, Foster MC, et al. Guidelines for performing a comprehensive transthoracic echocardiographic examination in adults: recommendations from the American Society of Echocardiography. *J Am Soc Echocardiogr.* 2019;32(1):1-64. doi:10.1016/j.echo.2018.06.004.
8. Iacobellis G, Willens HJ. Echocardiographic epicardial fat: a review of research and clinical applications. *J Am Soc Echocardiogr.* 2009;22(12):1311-9.
9. Iacobellis G, Barbaro G. Epicardial adipose tissue feeding and overfeeding the heart. *Nutrition.* 2019;59:1-6. doi:10.1016/j.nut.2018.07.002.
10. Reddy PKMK, Rayapu MR, Ravi S, Nagula P, Balla NVR, Maale SR. Interatrial septal thickness as a predictor of the presence and severity of coronary artery disease. *J Indian Acad Echocardiogr Cardiovasc Imaging.* 2023;7(1):1-7. doi:10.4103/jiae.jiae_28_22.
11. Jesrani G, Meena PK, Gautam DK, Choudhary S, Gupta S, Mahla H, et al. Correlation between interatrial septal thickness and severity of coronary artery disease in patients with myocardial infarction: an observational study. *J Pract Cardiovasc Sci.* 2026;12(1):24-29. doi:10.4103/jpcs.jpcs_72_25.
12. Hulley SB, Cummings SR, Browner WS, Grady DG, Newman TB. *Designing Clinical Research.* 4th ed. Philadelphia: Lippincott Williams & Wilkins; 2013.
13. Sianos G, Morel MA, Kappetein AP, Morice MC, Colombo A, Dawkins K, van den Brand M, Van Dyck N, Russell ME, Mohr FW, Serruys PW. The SYNTAX Score: an angiographic tool grading the complexity of coronary artery disease. *EuroIntervention.* 2005;1(2):219-227.
14. Lawton JS, Tamis-Holland JE, Bangalore S, Bates ER, Beckie TM, Bischoff JM, et al. 2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization. *Journal of the American College of Cardiology.* 2022 Jan;79(2):e21-129. doi:10.1016/j.jacc.2021.09.006.
15. Chaowalit N, Somers VK, Pellikka PA, Rihal CS, Lopez-Jimenez F. Adipose tissue of atrial septum as a marker of coronary artery disease. *Chest.* 2007;132(3):817-822. doi:10.1378/chest.06-2425.
16. Chakraborty S, Choudhury AK, Hashem S, Rahman MZ, Matin MA, Tamal AUR. Association of interatrial septal thickness with severity of coronary artery diseases. *Bangladesh Med Res Counc Bull.* 2025;51(1):25-32. doi:10.3329/bmrcb.v51i1.80399.
17. Agmon Y, Meissner I, Tajik AJ, Seward JB, Petterson TM, Christianson TJH, et al. Clinical, laboratory, and transesophageal echocardiographic correlates of interatrial septal thickness: A population-based transesophageal echocardiographic study. *Journal of the American Society of Echocardiography.* 2005 Feb;18(2):175-82. doi:10.1016/j.echo.2004.09.002.