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*Article*

# Visceral Adiposity Index and Postoperative Atrial Fibrillation After Isolated On-Pump Coronary Artery Bypass Grafting

Mehmet Emre Elci[1,*], Gozde Tekin[1], Selen Ozturk[1], Mehmet Kızılay[1]

[1]Department of Cardiovascular Surgery, Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital, 34668 Istanbul, Türkiye

*Correspondence: mehmetemreelci@gmail.com (Mehmet Emre Elci)

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**Abstract**

**Background:** Postoperative atrial fibrillation (PoAF) remains the most common complication after coronary artery bypass grafting (CABG). The visceral adiposity index (VAI) is a composite marker of visceral adipose dysfunction and metabolic risk. This study aimed to evaluate the association between preoperative VAI and PoAF in patients undergoing isolated on-pump CABG. **Methods:** This retrospective, single-center cohort study included 400 consecutive patients who underwent isolated on-pump CABG between January 2019 and December 2023. VAI was calculated using sex-specific formulas that incorporated body mass index, waist circumference, triglyceride levels, and high-density lipoprotein cholesterol levels. Patients were categorized according to the median VAI value (2.87) for descriptive analyses. The primary outcome was new-onset PoAF during the index hospitalization. Multivariable logistic regression analysis was performed to identify independent predictors of PoAF. Receiver operating characteristic (ROC) analysis was used to evaluate the discriminative performance of VAI. **Results:** PoAF occurred in 61 patients (15.3%). Patients with VAI $\geq$2.87 had a significantly higher incidence of PoAF than those with VAI <2.87 (21.4% vs. 9.0%; $p < 0.001$). In multivariable logistic regression analysis adjusted for age, sex, left ventricular ejection fraction, and cardiopulmonary bypass duration, VAI remained independently associated with PoAF (odds ratio (OR) 1.34 per unit increase, 95% confidence interval (CI) 1.09–1.63; $p = 0.005$). ROC analysis demonstrated good discriminative ability of VAI for predicting PoAF (area under the curve [AUC] 0.85, 95% CI 0.79–0.90). Exploratory ROC analysis identified a VAI threshold of 3.5, corresponding to a sensitivity of 91% and a specificity of 68%. **Conclusions:** Higher preoperative VAI was independently associated with PoAF in patients undergoing isolated on-pump CABG. As an easily obtainable marker of visceral adiposity and metabolic dysfunction, VAI may provide complementary information for preoperative risk assessment. However, the ROC findings should be considered exploratory, and external validation is required before routine clinical application.

**Keywords:** visceral adiposity index; postoperative atrial fibrillation; coronary artery bypass grafting; cardiometabolic risk; risk stratification

## 1. Introduction

Obesity has emerged as one of the leading contributors to cardiovascular morbidity and mortality worldwide and is closely associated with metabolic disorders including diabetes mellitus, hypertension, atherosclerotic cardiovascular disease, and heart failure [1,2]. However, traditional anthropometric measures, particularly body mass index (BMI), provide limited information regarding body fat distribution and metabolic activity. This limitation has contributed to the concept of the “obesity paradox”, in which BMI alone may not accurately reflect cardiovascular risk or predict clinical outcomes across different patient populations [3,4,5,6].

Recent evidence suggests that visceral adiposity, rather than total body weight, plays a central role in the development of cardiometabolic disease. Visceral adipose tissue functions as a metabolically active endocrine organ capable of promoting insulin resistance, oxidative stress, endothelial dysfunction, and chronic low-grade inflammation [7,8]. These mechanisms contribute to adverse cardiovascular remodeling and may facilitate the development of arrhythmogenic substrates. Consequently, growing interest has focused on indices that better characterize visceral adipose dysfunction and its metabolic consequences.

The visceral adiposity index (VAI) is a sex-specific composite measure derived from body mass index, waist circumference, triglyceride levels, and high-density lipoprotein cholesterol concentrations. Originally developed as a surrogate marker of visceral adipose tissue dysfunction, VAI has been shown to correlate with cardiometabolic risk and adverse cardiovascular outcomes in diverse populations [9,10,11,12]. Compared with isolated anthropometric parameters, VAI may provide a more comprehensive assessment of the metabolic burden associated with visceral fat accumulation.

Coronary artery bypass grafting (CABG) remains a cornerstone in the treatment of advanced coronary artery disease. Despite significant advances in surgical techniques and perioperative management, postoperative atrial fibrillation (PoAF) remains the most common complication after CABG, affecting approximately 20–40% of patients

[13,14,15]. The occurrence of PoAF is associated with prolonged hospitalization, increased healthcare utilization, and adverse clinical outcomes. Its pathogenesis is multifactorial and involves both patient-related and procedure-related determinants, including advanced age, impaired ventricular function, chronic pulmonary disease, hypertension, and operative factors [16,17].

Accumulating evidence indicates that adipose tissue may play a direct role in atrial arrhythmogenesis. Pericardial and epicardial fat depots have been associated with local inflammatory activation, autonomic imbalance, oxidative stress, and structural remodeling of the atrial myocardium, thereby increasing susceptibility to atrial fibrillation [18,19]. In parallel, recent investigations have reported associations between metabolic adiposity-related abnormalities, atrial dysfunction, and the subsequent development of atrial fibrillation, further supporting the biological plausibility of this relationship [20,21].

Interest in adiposity-related indices as predictors of PoAF has therefore increased substantially. Engin et al. [22] demonstrated that elevated VAI was independently associated with PoAF following on-pump CABG, while more recent studies have suggested that other markers reflecting visceral adiposity and metabolic dysfunction may also possess prognostic value in this setting [23]. Nevertheless, the role of VAI within contemporary perioperative risk assessment remains incompletely defined. In particular, it remains uncertain whether VAI provides clinically meaningful information beyond established perioperative risk factors and whether its composite structure offers advantages over its individual metabolic components.

Therefore, the present study aimed to evaluate the association between preoperative VAI and PoAF in patients undergoing isolated on-pump CABG. In addition, we explored the associations between VAI and selected intraoperative characteristics as secondary descriptive analyses.

## 2. Methods

### 2.1 Study Design and Population

This retrospective single-center cohort study included consecutive adult patients who underwent coronary artery bypass grafting (CABG) between January 2019 and December 2023 at Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital. During the study period, a total of 872 patients underwent CABG surgery. Patients were identified through the institutional cardiac surgery database and electronic medical records. Patients with incomplete records for variables required for VAI calculation or PoAF assessment were not eligible for inclusion in the final study cohort. After application of predefined exclusion criteria, 400 patients who underwent isolated on-pump CABG were included in the final analysis.

Patients were excluded if they underwent off-pump CABG, concomitant valve, aortic, or carotid surgery, emergency surgery, had a history of preoperative AF, renal dysfunction, thyroid dysfunction, morbid obesity (BMI >40 kg/m$^2$), or severe hypertriglyceridemia (triglycerides [TG] >500 mg/dL), as these conditions may affect the reliability of VAI calculation or postoperative rhythm assessment.

The study protocol was approved by the Clinical Research Ethics Committee of Haydarpaşa Numune Training and Research Hospital (Approval No: HNEAH-KAEK 2020/225) and was conducted in accordance with the Declaration of Helsinki. Owing to the retrospective nature of the study, the requirement for individual informed consent was waived.

### 2.2 Anthropometric Measurements and VAI Calculation

Body weight, height, and waist circumference (WC) were measured preoperatively under standardized conditions. Waist circumference was measured midway between the lowest rib and the iliac crest at the end of normal expiration.

Body mass index (BMI) was calculated as weight (kg) divided by height squared (m$^2$).

The visceral adiposity index (VAI) was calculated using previously validated sex-specific formulas incorporating BMI, WC, triglycerides (TG), and high-density lipoprotein cholesterol (HDL-C):

**Male:**

$$\mathrm{VAI} = [\mathrm{WC}/(39.68 + 1.88 \times \mathrm{BMI})] \times (\mathrm{TG}/1.03) \times (1.31/\mathrm{HDL\text{-}C})$$

**Female:**

$$\mathrm{VAI} = [\mathrm{WC}/(36.58 + 1.89 \times \mathrm{BMI})] \times (\mathrm{TG}/0.81) \times (1.52/\mathrm{HDL\text{-}C})$$

Triglyceride and HDL-C concentrations were originally measured in mg/dL and converted to mmol/L using standard conversion factors before VAI calculation.

For descriptive analyses presented in Table 1, patients were categorized according to the median VAI value of the study population (2.87). This grouping strategy was used solely for descriptive comparisons and was independent of the receiver operating characteristic (ROC) analysis. ROC-derived thresholds were not used for patient stratification or group comparisons.

### 2.3 Preoperative Assessment

Preoperative risk was assessed using EuroSCORE II. Fasting blood samples were obtained after an overnight fast of at least 12 hours and analyzed using standard enzymatic techniques. Lipid parameters included TG, HDL-C, and low-density lipoprotein cholesterol (LDL-C). Left ventricular ejection fraction (LVEF) was assessed by transthoracic echocardiography using standard institutional protocols.

**Table 1. Baseline, metabolic and intraoperative characteristics according to median VAI value (2.87).**

| Variable | Low VAI (<2.87) (n = 199) | High VAI (≥2.87) (n = 201) | *p*-value |
|---|---|---|---|
| Age (years) | 60 (55–66) | 58 (53–64) | 0.316 |
| Male sex, n (%) | 114 (57.3%) | 126 (62.7%) | 0.280 |
| Weight (kg) | 78.0 (69.5–85.0) | 76.0 (68.5–86.8) | 0.817 |
| Height (cm) | 173 (170–176) | 170 (163–176.5) | 0.034 |
| BMI (kg/m$^2$) | 25.9 (23.5–27.7) | 26.3 (24.5–29.8) | 0.186 |
| Waist circumference (cm) | 102 (90.5–111.5) | 105.5 (97.5–110) | 0.131 |
| LVEF (%) | 50 (42–60) | 50 (41–60) | 0.875 |
| EuroSCORE II | 2 (2–4) | 2 (1–3.75) | 0.128 |
| TG (mg/dL) | 109 (92.5–124) | 209.5 (168–288) | <0.001 |
| HDL-C (mg/dL) | 44 (38.5–50.5) | 34 (31–39.8) | <0.001 |
| LDL-C (mg/dL) | 111 (85–135) | 109 (83–149) | 0.639 |
| XCL time (min) | 59 (45–80) | 76 (56.5–88.7) | 0.015 |
| CPB time (min) | 94 (69.5–120.5) | 110 (95.3–131) | 0.006 |
| Number of grafts | 3 (2–3) | 3 (3–4) | 0.530 |

*Data are presented as median (interquartile range) or number (%).*

Abbreviations: BMI, body mass index; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; LVEF, left ventricular ejection fraction; TG, triglycerides; XCL, aortic cross-clamp; CPB, cardiopulmonary bypass; VAI, visceral adiposity index.

### *2.4 Operative Data*

All procedures were performed using cardiopulmonary bypass (CPB) under moderate systemic hypothermia (32 °C). Distal coronary anastomoses were performed first, followed by proximal anastomoses using a side-biting aortic clamp.

Myocardial protection was achieved using intermittent antegrade blood cardioplegia in all patients. The initial dose was administered after aortic cross-clamping and repeated at approximately 20-minute intervals. Subsequent doses were delivered either through completed bypass grafts or via the aortic root cannula according to the stage of the procedure.

The number of distal grafts, CPB duration, and aortic cross-clamp (XCL) duration were recorded. The use of inotropic support during separation from CPB was also documented.

### *2.5 Outcome Definition and Monitoring*

The primary endpoint was new-onset PoAF, defined as an episode lasting ≥30 seconds requiring pharmacological treatment, electrical cardioversion, or both during the index hospitalization.

All patients underwent continuous telemetry monitoring during their intensive care unit stay. Following ICU discharge, daily 12-lead electrocardiography was performed, and additional rhythm monitoring was obtained whenever clinically indicated.

Perioperative beta-blocker therapy was routinely used unless contraindicated. Most patients were receiving beta-blockers preoperatively; in patients not previously treated, beta-blocker therapy was initiated during the preoperative preparation period. Metoprolol was the preferred agent. Postoperatively, beta-blocker therapy was continued with dose adjustments according to body weight and clinical status according to institutional practice. In patients who developed PoAF, hemodynamic stability was assessed and optimized first, followed by rate-control therapy when clinically indicated.

### *2.6 Statistical Analysis*

Statistical analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were assessed for normality using the Kolmogorov–Smirnov test and are presented as mean ± standard deviation or median (interquartile range), as appropriate. Between-group comparisons were performed using Student's *t*-test or the Mann–Whitney U test. Categorical variables are presented as frequencies and percentages and were compared using the chi-square test or Fisher's exact test.

Correlations between VAI and selected clinical variables were assessed using Spearman correlation analysis.

To identify independent predictors of PoAF, multivariable logistic regression analysis was performed using clinically relevant variables selected a priori. The final model included age, sex, LVEF, CPB duration, and VAI.

Given the number of outcome events, the number of covariates included in the multivariable model was intentionally restricted to reduce the risk of model overfitting. Variables with conceptual or mathematical overlap were not entered simultaneously into the same model. In particular, BMI was not included because it constitutes a component of VAI. EuroSCORE II was not included in the final model because it incorporates several clinical variables already considered separately.

VAI was analyzed as a continuous variable. Given the exploratory nature of the study and the limited number of outcome events, formal non-linearity modeling was not performed, and VAI was entered as a continuous predictor in the final model. Accordingly, the reported odds ratio should be interpreted as an average effect across the observed range of VAI values.

Adjusted odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were reported. Model calibration was assessed using the Hosmer–Lemeshow goodness-of-fit test.

Receiver operating characteristic (ROC) curve analysis was performed to evaluate the discriminative performance of VAI. This analysis was considered exploratory and was not intended to establish a clinically validated threshold. Therefore, any reported cut-off values should be interpreted cautiously and require validation in independent cohorts.

Data completeness was verified during chart review. Complete information was available for all variables included in the final analysis; therefore, no imputation procedures were required.

All analyses were performed in accordance with STROBE recommendations. A two-sided $p$-value $< 0.05$ was considered statistically significant.

**Table 2. Relationship between median-based VAI groups and categorical variables.**

| Variable | Low VAI (<2.87) (n = 199) | High VAI (≥2.87) (n = 201) | $p$-value |
|---|---|---|---|
| Inotropic support | | | 0.060 |
| No | 127 (63.8%) | 104 (51.7%) | |
| Yes | 72 (36.2%) | 97 (48.3%) | |
| PoAF | | | <0.001 |
| No | 181 (91.1%) | 158 (78.6%) | |
| Yes | 18 (9.0%) | 43 (21.4%) | |

*Categorical variables are presented as counts and percentages and were compared using the chi-square test.*

Abbreviation: PoAF, Postoperative atrial fibrillation.

## 3. Results

### 3.1 Baseline and Intraoperative Characteristics

A total of 400 patients who underwent isolated on-pump coronary artery bypass grafting were included in the analysis. Baseline demographic, metabolic, and intraoperative characteristics are summarized in Table 1.

There were no significant differences between the low-VAI and high-VAI groups in body weight, BMI, waist circumference, LVEF, or EuroSCORE II (all $p > 0.05$). Height was slightly greater in the low-VAI group ($p$ = 0.034).

As expected, patients in the high-VAI group had significantly higher triglyceride levels and lower HDL-C levels (both $p < 0.001$), reflecting the metabolic components incorporated into the VAI formula. LDL-C levels were comparable between groups ($p$ = 0.639).

With regard to operative variables, the number of distal grafts did not differ significantly between groups ($p$ = 0.530). However, CPB duration and XCL duration were significantly longer in patients with higher VAI values ($p$ = 0.006 and $p$ = 0.015, respectively).

### 3.2 PoAF and Early Outcomes

The incidence of PoAF was significantly higher in the high-VAI group than in the low-VAI group (21.4% vs. 9.0%, $p < 0.001$) (Table 2, Fig. 1).

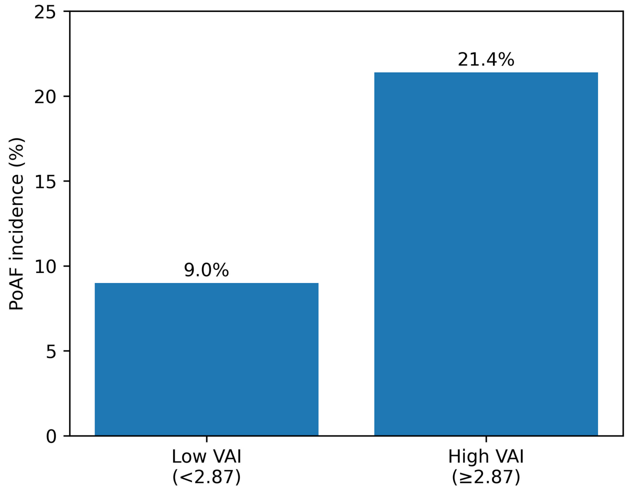


**Fig. 1. Incidence of PoAF according to median-based VAI groups.** Patients with VAI values ≥2.87 had a significantly higher incidence of PoAF compared with patients with VAI values <2.87 (21.4% vs. 9.0%, $p < 0.001$). Differences between groups were assessed using the chi-square test.

Consistent with this descriptive comparison, patients in the high-VAI group had a significantly greater likelihood of developing PoAF in univariable analysis (OR 2.74, 95% CI 1.50–5.10, $p < 0.001$). In addition, patients who developed PoAF had significantly higher VAI values than those who remained in sinus rhythm (Fig. 2).

The need for inotropic support was numerically higher in the high-VAI group; however, this difference did not reach statistical significance (48.3% vs. 36.2%, $p$ = 0.060).

### 3.3 Multivariable Analysis

Multivariable logistic regression analysis was performed to identify independent predictors of PoAF (Table 3). After adjustment for age, sex, LVEF, and CPB duration, VAI remained independently associated with PoAF (OR 1.34 per unit increase, 95% CI 1.09–1.63, $p$ = 0.005).

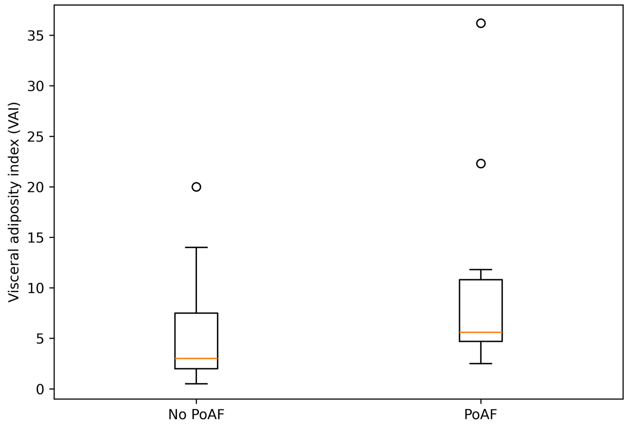


**Fig. 2. Distribution of visceral adiposity index values according to postoperative atrial fibrillation status**. Box-and-whisker plot showing VAI values in patients with and without PoAF. Patients who developed PoAF exhibited higher VAI values than those who remained in sinus rhythm. The central line represents the median, boxes indicate the interquartile range, whiskers represent the data range excluding outliers, and circles denote outlying observations. Group comparisons were performed using the Mann–Whitney U test.

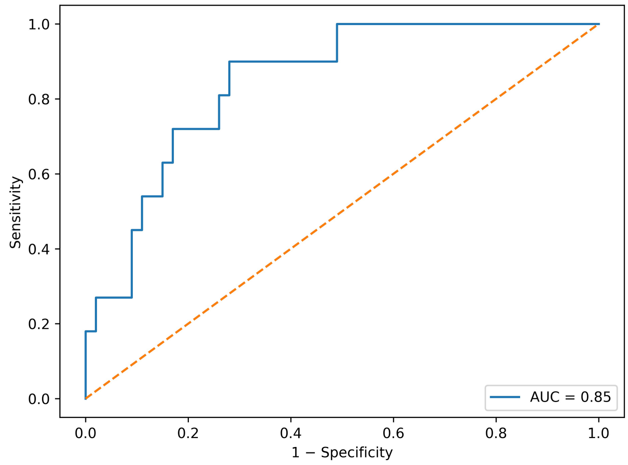


**Fig. 3. Receiver operating characteristic curve of VAI for prediction of postoperative atrial fibrillation**. Receiver operating characteristic (ROC) analysis demonstrated good discriminative performance of VAI for predicting PoAF, with an area under the curve (AUC) of 0.85 (95% CI 0.79–0.90). Given the absence of internal or external validation, the reported AUC and the identified threshold should be considered exploratory.

**Table 3. Multivariable logistic regression analysis for PoAF**.

| Variable | OR | 95% CI | *p* |
|---|---|---|---|
| VAI (per unit increase) | 1.34 | 1.09–1.63 | 0.005 |
| Age | 1.09 | 0.93–1.27 | 0.310 |
| Sex (male) | 1.12 | 0.58–2.18 | 0.742 |
| LVEF | 1.00 | 0.91–1.11 | 0.976 |
| CPB time | 0.98 | 0.93–1.04 | 0.603 |

*Variables were selected a priori based on clinical relevance. Odds ratios (ORs) with 95% confidence intervals (CIs) are reported. Model calibration was acceptable according to the Hosmer–Lemeshow goodness-of-fit test ($\chi^2$ = 8.06, p = 0.427).*
Abbreviations: OR, odds ratio; CI, confidence interval; LVEF, left ventricular ejection fraction; CPB, cardiopulmonary bypass.

After multivariable adjustment, VAI was the only variable independently associated with PoAF, whereas age, sex, LVEF, and CPB duration were not statistically significant predictors (all $p > 0.05$).

### *3.4 ROC Analysis*

Receiver operating characteristic (ROC) curve analysis demonstrated that VAI had good discriminative ability for predicting PoAF, with an area under the curve (AUC) of 0.85 (95% CI 0.79–0.90) (Fig. 3).

Given the absence of internal or external validation, these findings should be considered exploratory. The optimal VAI threshold identified in the present cohort was 3.5, corresponding to a sensitivity of 91% and a specificity of 68%.

Although the discriminative performance observed in the present cohort was encouraging, external validation in independent populations is required before this threshold can be considered for routine clinical application.

## 4. Discussion

In this retrospective cohort of patients undergoing isolated on-pump CABG, higher preoperative VAI values were associated with an increased incidence of PoAF. Importantly, this relationship persisted after adjustment for age, sex, LVEF, and CPB duration. These findings suggest that metabolic abnormalities related to visceral adiposity may contribute to PoAF beyond conventional perioperative risk factors.

Interest in visceral adiposity has increased considerably in recent years because conventional measures such as BMI provide only limited insight into adipose tissue distribution and metabolic activity. Unlike BMI, VAI combines anthropometric and biochemical parameters and is intended to reflect visceral adipose dysfunction rather than body size alone [9,10,11,12]. The limitations of BMI as a risk stratification tool in cardiovascular disease and cardiac surgery have been highlighted in studies investigating the obesity paradox and postoperative outcomes [3,4,5,6,24]. Therefore, markers reflecting metabolic dysfunction may offer clinically relevant information that is not fully captured by traditional obesity measures.

Our findings are in agreement with previous investigations evaluating adiposity-related markers in cardiac surgery populations. Engin et al. [22] demonstrated an independent association between elevated VAI and PoAF after on-pump CABG. More recently, Kahraman and Cetin [23] reported that the cardiometabolic index predicted PoAF and showed favorable discriminatory performance compared with several traditional obesity-related measures. Although the present study was not designed to compare VAI with alternative adiposity indices, the consistency of these findings supports a potential relationship between metabolic dysfunction and postoperative atrial arrhythmogenesis.

Several biological mechanisms may explain this association. Visceral adipose tissue promotes systemic inflammation, oxidative stress, endothelial dysfunction, and insulin resistance, all of which may contribute to adverse atrial remodeling [7,8,20]. In addition, pericardial and epicardial adipose tissue may exert local effects on the atrial myocardium through inflammatory and profibrotic signaling pathways [18,19]. Recent studies have further linked visceral adiposity and metabolic abnormalities with atrial dysfunction and incident AF, providing additional mechanistic support for the observed relationship [21].

An additional observation was that patients with higher VAI values had longer CPB and XCL durations. However, neither variable remained independently associated with PoAF after multivariable adjustment. Previous studies have demonstrated associations between prolonged CPB and XCL durations and adverse postoperative outcomes; however, their specific relationship with PoAF remains less consistent [17,25]. Our findings suggest that metabolic dysfunction reflected by VAI may represent an aspect of patient vulnerability that is not fully explained by operative complexity alone. The underlying explanation for the observed association between higher VAI values and longer CPB and XCL durations remains uncertain and should be considered hypothesis-generating.

PoAF is a multifactorial complication influenced by numerous clinical and procedural factors. Advanced age, impaired ventricular function, pulmonary disease, hypertension, renal dysfunction, left atrial enlargement, and perioperative inflammatory activation have all been implicated in its pathogenesis [16,17]. Reduced ventricular function has also been associated with worse outcomes after cardiac surgery in several cohorts [26]. Accordingly, our findings should not be interpreted as evidence that VAI replaces established predictors. Instead, VAI may represent a complementary marker reflecting the metabolic and inflammatory milieu that predisposes patients to PoAF. Although advanced age is widely recognized as one of the strongest predictors of PoAF, age was not independently associated with the outcome in the present cohort. This finding may be related to the relatively limited sample size and number of outcome events and should therefore be interpreted cautiously.

An important consideration is that VAI is derived from triglycerides, HDL cholesterol, BMI, and waist circumference. Although VAI remained independently associated with PoAF in the present analysis, our study was not designed to determine whether VAI provides incremental predictive value beyond its individual components. Similarly, direct comparisons with other emerging adiposity-related indices, such as the cardiometabolic index, lipid accumulation product, or body roundness index, were beyond the scope of the present study. Future investigations addressing these questions may help define the relative clinical utility of VAI and clarify whether its composite structure provides advantages over simpler metabolic markers [12,23].

From a practical standpoint, VAI can be calculated easily from routinely available clinical and laboratory data without additional imaging or cost. For this reason, it may represent a useful adjunct during preoperative evaluation. Nevertheless, the present findings do not support the use of VAI as an isolated risk stratification tool, and any potential clinical application should be considered complementary to established perioperative risk assessment strategies and validated cardiac surgery risk models [27,28]. Furthermore, metabolic factors such as glycemic control have been associated with long-term outcomes after CABG, supporting the broader concept that metabolic health influences postoperative prognosis [29,30].

## 5. Limitations

Several limitations should be acknowledged. First, the retrospective single-center design introduces the possibility of selection bias and may limit the generalizability of the findings. Second, although multivariable adjustment was performed using clinically selected variables, residual confounding remains possible. Several established predictors of PoAF, including left atrial size, chronic obstructive pulmonary disease, smoking status, mild-to-moderate valvular abnormalities, and detailed perioperative medication-related variables, were not available for inclusion in the final model. Third, the relatively limited number of outcome events may have affected model stability despite efforts to minimize overfitting. Fourth, VAI was measured at a single preoperative time point and may not fully reflect dynamic perioperative metabolic changes. Fifth, potential non-linear associations between VAI and PoAF were not formally evaluated; therefore, the reported odds ratio should be interpreted as an average effect across the observed range of VAI values. Finally, the ROC analysis was performed in the same cohort used for model development and was not subjected to internal or external validation. Consequently, the reported AUC (0.85; 95% CI 0.79–0.90) and optimal threshold should be considered exploratory and may overestimate true predictive performance.

## 6. Clinical Implications and Future Directions

The present findings further support the concept that metabolic dysfunction contributes to the development of PoAF after CABG. As a simple index derived from routinely available anthropometric and laboratory parameters, VAI may serve as a practical marker of the metabolic burden associated with postoperative arrhythmic risk. Given its ease of calculation and low cost, VAI may represent a useful adjunct to existing approaches to preoperative risk assessment, although further validation is required before routine clinical implementation.

However, the incremental predictive value of VAI beyond established clinical, echocardiographic, and perioperative risk factors remains uncertain. In addition, it is unclear whether VAI provides superior prognostic information compared with its individual components or other emerging adiposity-related indices. Future prospective multicenter studies incorporating external validation, direct comparison with alternative metabolic markers, and integration into established risk prediction models are needed to better define the clinical utility of VAI in patients undergoing CABG.

## 7. Conclusion

Higher preoperative VAI was independently associated with PoAF in patients undergoing isolated on-pump CABG. As an easily obtainable marker of visceral adiposity and metabolic dysfunction, VAI may provide complementary information during preoperative risk assessment. Nevertheless, these findings should be interpreted cautiously. External validation and prospective confirmation are required before VAI can be considered for routine clinical implementation.

## Availability of Data and Materials

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

## Author Contributions

MEE conceived and designed the study. MEE and GT collected the data. MEE performed the statistical analysis and drafted the manuscript. GT, SO, and MK contributed to data interpretation and critically revised the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

## Ethics Approval and Consent to Participate

The study protocol was approved by the Clinical Research Ethics Committee of Haydarpaşa Numune Training and Research Hospital (Approval No: HNEAH-KAEK 2020/225) and conducted in accordance with the Declaration of Helsinki. Given the retrospective nature of the study, the requirement for individual informed consent was waived by the ethics committee.


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## Conflicts of Interest

The authors declare no conflict of interest.

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