Evaluation of SYNTAX 2 Score and Visceral Adiposity Index in Patients Undergoing Isolated On-Pump Coronary Artery Bypass Grafting

Ann. Ital. Chir., 2025 96, 9: 1218–1225
https://doi.org/10.62713/aic.4017

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AIM: We aim to investigate the relationship between the synergy between percutaneous coronary intervention and cardiac surgery (SYNTAX) scoring system created with coronary angiographic and clinical parameters and the Visceral Adiposity Index (VAI), which includes anthropometric parameters and blood lipid values and is to evaluate their predictive power complications after coronary artery bypass grafting (CABG).

METHODS: This prospective observational clinical study was conducted between 15 August 2023 to 1 December 2023. A total of 173 patients who underwent isolated CABG were included. SYNTAX 2 scores, VAI results, and complications occurring in the postoperative period were recorded. All patients were divided into two separate groups, low and high, according to the median value of the SYNTAX 2 score and VAI. Postoperative complications were compared between groups, and correlation and predictive analyses were performed.

RESULTS: Intra-Aortic balloon pump (IABP) use and low cardiac output were more frequent in the group with a high SYNTAX 2 score. However, this difference was significant for IABP use but not for low cardiac output (LCO) (p = 0.011 and p = 0.109). A positive correlation was observed between VAI and intensive care unit stay and postoperative respiratory complications (p = 0.018 and p = 0.035). There was no statistically significant correlation between SYNTAX 2 score and VAI value (p = 0.540). In Receiver Operating Characteristic (ROC) analysis, it was determined that VAI could predict respiratory complications and SYNTAX 2 score could predict IABP requirement [area under the curve (AUC): 0.639, 95% CI: 0.531–0.746, p = 0.036 and, AUC: 0.799, 95% CI: 0.678–0.920, p = 0.001].

CONCLUSIONS: In our study, no correlation was found between SYNTAX 2 score and VAI. However, we found that high VAI can predict postoperative respiratory complications and that a high SYNTAX 2 score is associated with postoperative IABP requirement. These parameters can be taken into account in risk assessments.

Keywords: SYNTAX 2 score; visceral adiposity index; coronary artery bypass graft; postoperative complication

Introduction

Coronary artery disease (CAD) is one of the most important diseases affecting the global population. This disease has been proven to be among the leading causes of death in both developed and developing countries [1]. Coronary revascularization guidelines demonstrated that, when compared to a medical treatment strategy alone, coronary artery bypass grafting (CABG) or percutaneous coronary intervention more effectively relieves angina, and enhances exercise capacity and quality of life [2]. Also, a study reported that patients with higher risk scores benefit better from CABG surgery [3]. Numerous studies have been conducted to determine the surgical risk factors of CAD and preoperative risk scoring has become extremely important in patients undergoing CABG surgery [4,5].

Synergy between percutaneous coronary intervention and cardiac surgery (SYNTAX) 2 score is designed to better predict the risks of percutaneous or surgical coronary revascularization, and therefore the risk of any complications in the postoperative period, by evaluating the functional characteristics of the coronary circulation and co-existing clinical conditions. It contains many angiography parameters related to the nature of the lesions in the patient's coronary artery anatomy [6]. Recently, several authors have used SYNTAX scores to predict serious adverse cardiac and cerebrovascular events that may emerge following CABG [7,8]. Many recent studies are showing that the Visceral Adiposity Index (VAI) can be considered a marker of adipose tissue dysfunction, which indirectly expresses cardiometabolic risk [9,10]. It can be calculated only by knowing the patient's cholesterol, lipid levels, height, weight, and waist circumference measurements. A large cohort study has shown its association with coronary artery disease and all-cause mortality [9]. In a study conducted in the cardio-

Submitted: 20 February 2025 Revised: 25 March 2025 Accepted: 14 April 2025 Published: 7 August 2025
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vascular field, its relationship with atrial fibrillation, which is an undesirable postoperative problem, has been demonstrated [10].

The present study aims to elucidate whether there is a relationship between SYNTAX 2 score and VAI. And, whether VAI could be used as a parameter with more practical daily clinical use to predict possible postoperative complications in patients undergoing CABG surgery.

Materials and Methods

Patients

This study is a prospective observational clinical study and was conducted between 15 August 2023 to 1 December 2023 at the Department of Cardiovascular Surgery, University of Health Sciences, Bursa Yuksek Ihtisas Training and Research Hospital. Our study was approved by the Clinical Research Ethics Committee of Bursa Yuksek Ihtisas Training and Research Hospital with the protocol number 2011-KAEK-25 2023/07-02 (Date: 26 July 2023). Informed consent was obtained from all patients included in the study. All procedures were performed following the Declaration of Helsinki. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines were utilized for this study [11]. For the present study, patients over the age of 18 who underwent isolated on-pump CABG surgery were evaluated. In addition to CABG, patients who underwent simultaneous heart valve surgery, carotid artery surgery, or aortic surgery, patients receiving dialysis due to chronic renal failure (CRF), patients with malignancy, those with severe and very severe chronic obstructive pulmonary disease (COPD), patients with uncontrolled diabetes mellitus (DM) (HbA1c >8.5%), patients with thyroid hormone disorders patients, those receiving preoperative antibiotic therapy or steroid therapy who underwent CABG surgery under emergency conditions, patients who underwent redo heart surgery and bleeding revision was excluded from the study.

All data were recorded as age, gender, history of hypertension, DM, COPD, peripheral arterial disease (PAD), smoking, waist circumference, ejection fraction, and body mass index. Laboratory parameters were also studied from venous blood samples before the surgery. In the postoperative period, intra-aortic balloon pump (IABP) requirement, development of postoperative atrial fibrillation (PoAF), respiratory complications (pneumonia, atelectasis), sternal wound infection (SWI), low cardiac output (LCO), cerebrovascular accident, acute renal failure development, duration of intensive care unit (ICU) stay, death and the discharge time from the hospital was added to the records. Death cases occurring within the first 30 days after surgery were defined as operative mortality.

All patients were divided into two groups according to SYNTAX 2 score and VAI median values and were analyzed.

SYNTAX Score Analysis

Coronary angiographies of the patients were evaluated to calculate the SYNTAX score. To calculate the SYNTAX 2 score, echocardiography findings, biochemical markers, and medical histories of the patients obtained during their preoperative hospitalization in our hospital were evaluated. Calculators available on the website www.syntaxscore.org were used as calculation tools.

Calculation of Visceral Adiposity Index

In the VAI calculation process, cholesterol and lipid levels were recorded among the biochemical values obtained during the preoperative hospitalization period of the patients, and waist circumference (WC), height, weight, and Body Mass Index (BMI) values were recorded during this process, and VAI was calculated as described in previous studies [10,12].

Following the calculation and recording of all these values and scores, the postoperative ICU stay and hospital discharge times of the patients and the complications that occurred during this process were recorded. In the present study, the clinical data obtained in the postoperative period, the data obtained in the preoperative period, and the calculated scores were compared.

Statistical Analysis

SPSS 26.0 program (64-bit; IBM Institute, Armonk, NY, USA) was used in the statistical analysis of the data in the present study. According to the median values of SYNTAX 2 and VAI values, two groups were created: Group 1 (low) and Group 2 (high). The Kolmogorov-Smirnov test was utilized to analyze the normality of the distribution. Continuous variables that comply with normal distribution are expressed as mean ± standard deviation; continuous variables that do not comply with normal distribution are expressed as median (minimum-maximum). In contrast, nominal variables are expressed as frequency and percentage. Student's *t*-test was performed for normally distributed data. Mann-Whitney U tests were performed for non-normally distributed data, and nominal data were compared with the Chi-Squared test. Fisher's Exact test was considered for nominal data containing 1 or fewer observed outcomes. In the comparison of categorical variables between groups, the Chi-Square test with continuity correction was used when the theoretical frequency was $1 \leq \text{count} < 5$.

To investigate the relationship between SYNTAX 2 and VAI levels with patient parameters and complications, the Pearson or Spearman correlation coefficient test was used, depending on the distribution of the parameters. ROC curve [area under the curve (AUC)] was applied to estimate the effect of SYNTAX 2 and VAI levels on postoperative complications. To analyze the diagnostic value of SYNTAX 2 and VAI levels, cut-off values measured by the sensitivity and specificity of the area under the Receiver Operating Char-

Table 1. Demographic, laboratory, and postoperative data of all patients.

Demographic Data	N = 173
Age (year)	61 (38–81)
Gender	
Male, n (%)	135 (78)
Female, n (%)	38 (22)
Hypertension, n (%)	115 (67)
Diabetes Mellitus, n (%)	81 (47)
COPD, n (%)	38 (22)
PAD, n (%)	15 (9)
Smoker, n (%)	92 (53)
Waist Circumference (cm)	104 (76–150)
Body Mass Index (kg/m^2)	28.09 (18.5–42.7)
Ejection Fraction (%)	50 (25–65)
SYNTAX	24 (11–46.5)
SYNTAX 2	32.5 (13.7–57.1)
Visceral Adiposity Index	2.59 (0.45–10.5)
Laboratory data	
HDL-C (mg/dL)	40.9 (23–93.7)
LDL-C (mg/dL)	98.7 (7.6–315.4)
Total Cholesterol (mg/dL)	175 (98–435)
Triglyceride (mg/dL)	165 (38–604)
Creatinine (mg/dL)	0.97 (0.55–2.33)
GFR (mL/min/1.73 m^2)	82.94 (27.7–116.7)
Postoperative Data	
IABP, n (%)	12 (6.9)
PoAF, n (%)	52 (30.1)
Respiratory Complications, n (%)	22 (12.7)
SWI, n (%)	9 (5.2)
Stroke, n (%)	7 (4)
LCO, n (%)	3 (1.7)
ARF, n (%)	1 (0.6)
Mortality, n (%)	5 (2.9)
ICU Stay (day)	2 (2–26)
Hospital Stay (day)	8 (5–58)

COPD, chronic obstructive pulmonary disease; PAD, peripheral artery disease; SYNTAX, synergy between percutaneous coronary intervention and cardiac surgery; GFR, glomerular filtration rate; IABP, intra-aortic balloon pump; PoAF, postoperative atrial fibrillation; ARF, acute renal failure; LDL, low density lipoprotein; HDL, high density lipoprotein; SWI, sternal wound infection; LCO, low cardiac output; ICU, intensive care unit. Data are given as median (minimum-maximum) and numbers (percentage). GFR measurement was calculated in estimated glomerular filtration rate (eGFR)/Modification in Diet in Renal Disease (MDRD) formula.

acteristic (ROC) curve were calculated. A p-value of less than 0.05 was considered statistically significant in all tests.

Results

Demographic, laboratory, and postoperative data of all patients included in the study are shown in Table 1. 78% of the patients were male and 22% were female, and the median age was 61. Hypertension was detected in 67% of all patients, and diabetes mellitus in 47%. While 6.9% of the patients required IABP in the postoperative period, according to frequency, PoAF was detected in 30.1%, respiratory complications in 12.7%, and SWI in 5.2%, respectively. Mortality was observed in 2.9% of all patients.

All patients were divided into two, according to the median value of the SYNTAX 2 score: those below 33 as the low group, and those with 33 and above as the high group (Table 2). In our study, the median SYNTAX 2 value was 32.5. To ensure balance in patient groups, we divided them into groups according to the value of 33. The age was higher in the group with a high SYNTAX 2 score and this was statistically significant ($p < 0.001$). The differences between the two groups in terms of COPD, PAD incidence rate, SYNTAX score, and ejection fraction (EF) were found to be statistically significant ($p = 0.013$, $p < 0.001$, $p = 0.014$, $p < 0.001$, respectively). Likewise, there were differences in creatinine level and glomerular filtration rate (GFR) values and they were statistically significant ($p < 0.001$ and $p < 0.001$, respectively). These results were expected since the parameters are a factor in SYNTAX 2 score calculations. VAI was found to be higher in the group with a high SYNTAX 2 score compared to the group with a low score, but this was not statistically significant ($p = 0.279$).

In the comparison made considering the postoperative findings, it was determined that the postoperative IABP requirement in the group with a high SYNTAX 2 score was statistically significantly higher than the group with a low score ($p = 0.011$). Additionally, LCO syndrome was found to be more common in the group with high SYNTAX 2 scores than in the group with low scores, but statistical significance was not found ($p = 0.109$). A statistically significant difference was observed between the groups in terms of ICU stay and hospital stay ($p = 0.003$, $p = 0.032$, respectively).

According to the median value of the VAI score, all patients were divided into two: those with a VAI value of 2.59 and below, the low group, and those with a VAI value above 2.59, the high group (Table 3). WC measurements, BMI values and triglyceride levels, which are factors in VAI calculations, were found to be statistically significantly higher in the group with high VAI values, as expected (Table 3). In the VAI grouping, no significant difference was detected between the groups in terms of postoperative findings, except for ICU stay ($p = 0.008$).

According to the results of the correlation analysis (Table 4), a statistically significant weak positive correlation was found between the SYNTAX 2 score and IABP requirement, postoperative ICU stay times, and hospital stay times ($p < 0.001$). A statistically significant weak positive correlation was found between VAI value and length of stay in intensive care unit and postoperative respiratory complications ($p = 0.018$, $p = 0.035$). There was no statistically significant correlation between SYNTAX 2 score and VAI value ($p = 0.540$).

Table 2. Demographic, laboratory, and postoperative data of all patients according to SYNTAX 2 score.

Demographic Data	SYNTAX 2 ≤32.9 (n = 90)	SYNTAX 2 ≥33 (n = 83)	Test Statistic χ^2- *t*- Z	*p*
Age (year)	58 (50–64)	69 (60–73)	6.02	<0.001[a]
Gender			12.89	<0.001[#]
Male, n (%)	80 (89)	55 (66)		
Female, n (%)	10 (11)	28 (34)		
Hypertension, n (%)	55 (61)	60 (72)	2.42	0.120[#]
Diabetes Mellitus, n (%)	40 (44)	41 (49)	0.42	0.514[#]
COPD, n (%)	13 (14)	25 (30)	6.19	0.013[#]
PAD, n (%)	1 (1)	14 (17)	13.53	<0.001[#]
Smoker, n (%)	56 (62)	36 (43)	6.16	0.013[#]
Waist Circumference, (cm)	103 ± 11.3	105.1 ± 11.7	0.86	0.391*
Body Mass Index, (kg/m^2)	28.3 (25.4–31.3)	27.4 (24.7–30.8)	0.79	0.426[a]
Ejection Fraction, (%)	55 (50–60)	45 (40–55)	4.98	<0.001[a]
SYNTAX	23.3 ± 6.1	25.8 ± 7.1	2.49	0.014*
Visceral Adiposity Index	2.4 (1.5–3.6)	2.8 (1.8–3.9)	1.08	0.279[a]
Laboratory Data				
HDL-C (mg/dL)	40.6 (33.8–48.2)	42 (35.4–53.6)	1.50	0.134[a]
LDL-C (mg/dL)	103 (80.4–127.2)	94.6 (70.3–119.7)	1.14	0.251[a]
Total Cholesterol (mg/dL)	179.5 (154–206.3)	171 (151–201)	0.95	0.338[a]
Triglyceride (mg/dL)	162 (109.5–204.3)	169 (122–199)	0.23	0.816[a]
Creatinine (mg/dL)	0.87 (0.74–1.02)	1.08 (0.89–1.29)	5.30	<0.001[a]
GFR (mL/min/1.73 m^2)	91.8 ± 14.8	66.8 ± 20.6	9.26	<0.001*
Postoperative Data				
IABP, n (%)	2 (2)	10 (12)	6.45	0.011[#]
PoAF, n (%)	27 (30)	25 (30)	0.00	0.986[#]
Respiratory Complications, n (%)	11 (12)	11 (13)	0.04	0.839[#]
SWI, n (%)	5 (6)	3 (4)	0.06	0.806[c]
Stroke, n (%)	3 (3)	4 (5)	0.12	0.913[c]
LCO, n (%)	0 (0)	4 (5)	2.56	0.109[c]
ARF, n (%)	0 (0)	1 (1)		0.480[b]
Mortality, n (%)	1 (1)	4 (5)	1.00	0.317[c]
ICU Stay (day)	2 (2–3)	3 (2–4)	2.93	0.003[a]
Hospital Stay (day)	7 (7–10)	8 (7–12)	2.14	0.032[a]

Data are given as mean ± standard deviation, median (minimum-maximum), and numbers (percentage). GFR measurement was calculated in the eGFR/MDRD formula.

*Student's *t*-test, [#] Pearson Chi-Square, [a] Mann-Whitney U test, [b] Fisher's Exact test. [c] Adjusted Chi-Square, Test statistics: Chi-Square value for categorical data, standardized Z value for Mann-Whitney U test, and *t* value for *t*-test.

In ROC curve analyzes performed to predict postoperative complications of SYNTAX 2 score and VAI values; it was calculated that the VAI value could predict respiratory complications with 63.6% sensitivity and 58.9% specificity at levels above the 2.8 cut-off value, and this analysis was found to be statistically significant [AUC: 0.639, 95% CI: 0.531–0.746, $p = 0.036$] (Fig. 1). It was calculated that SYNTAX 2 score could predict the need for postoperative IABP with 83.3% sensitivity and 76.4% specificity at levels above the 39.1 cut-off value, and this analysis was found to be statistically significant (AUC: 0.799, 95% CI: 0.678–0.920, $p = 0.001$) (Fig. 2).

Discussion

There are many studies in the literature about patients undergoing CABG surgery, but there are not many studies examining the prediction of SYNTAX 2 score and VAI on postoperative complications in these patients and their relationship with each other. 173 patients who underwent isolated CABG surgery were included in this study. In our study, we did not find a relationship between SYNTAX 2 score and VAI, but we determined that high VAI and high SYNTAX 2 score could predict complications in the postoperative period.

The demographic and laboratory data of the patients included in the study were similar to the literature in terms

Table 3. Demographic, laboratory and postoperative data of all patients according to visceral adiposity index.

Demographic Data	VAI ≤2.59 (n = 89)	VAI >2.59 (n = 84)	Test Statistic χ^2- *t*- Z	*p*
Age (year)	64 (57–70)	60 (53–70)	1.26	0.207[a]
Gender			4.15	0.041[#]
Male, n (%)	75 (84)	60 (71)		
Female, n (%)	14 (16)	24 (29)		
Hypertension, n (%)	58 (65)	57 (68)	0.14	0.708[#]
Diabetes Mellitus, n (%)	37 (42)	44 (52)	2.02	0.154[#]
COPD, n (%)	19 (21)	19 (23)	0.41	0.840[#]
PAD, n (%)	7 (8)	8 (10)	0.15	0.698[#]
Smoker, n (%)	45 (51)	47 (56)	0.5	0.478[#]
Waist Circumference (cm)	101.7 ± 11.26	107.2 ± 11.1	3.19	0.002*
Body Mass Index (kg/m^2)	27 (24–30.2)	28.9 (25.9–32)	2.84	0.005[a]
Ejection Fraction, (%)	55 (45–60)	50 (40–60)	0.73	0.466[a]
SYNTAX	24.7 ± 7	24.3 ± 6.4	0.32	0.748*
SYNTAX 2	31.5 (24.5–39)	35.1 (26.6–40.1)	1.39	0.164[a]
Laboratory Data				
HDL-C (mg/dL)	47.4 (40.7–56.8)	35.8 (32.2–40.8)	7.42	<0.001[a]
LDL-C (mg/dL)	101.9 (78–125.4)	97 (71.7–130.6)	0.11	0.908[a]
Total Cholesterol (mg/dL)	175 (152–202)	180.5 (152.5–211.3)	0.94	0.347[a]
Triglyceride (mg/dL)	119 (91–155)	199.5 (178.3–259.8)	9.83	<0.001[a]
Creatinine (mg/dL)	0.97 (0.83–1.12)	1 (0.8–1.2)	0.75	0.450[a]
GFR (mL/min/1.73 m^2)	79.2 ± 19.1	80.5 ± 24.3	0.39	0.692*
Postoperative Data				
IABP, n (%)	9 (10)	3 (4)	2.86	0.091[#]
PoAF, n (%)	29 (33)	23 (27)	0.55	0.456[#]
Respiratory Complications, n (%)	8 (9)	14 (17)	2.29	0.130[#]
SWI, n (%)	2 (2)	7 (8)	2.12	0.145[c]
Stroke, n (%)	3 (3)	4 (5)	0.01	0.938[c]
LCO, n (%)	2 (2)	3 (4)	0.04	0.948[c]
ARF, n (%)	1 (1)	0 (0)		1.000[b]
Mortality, n (%)	4 (5)	1 (1)	0.71	0.400[c]
ICU Stay (day)	2 (2–3)	3 (2–4)	2.66	0.008[a]
Hospital Stay (day)	7 (7–10)	8 (7–13)	1.37	0.169[a]

VAI, Visceral Adiposity Index.

Data are given as mean ± standard deviation, median (minimum-maximum), and numbers (percentage). GFR measurement was calculated in the eGFR/MDRD formula.

*Student's *t*-test, [#] Pearson Chi-Square, [a] Mann-Whitney U test, [b] Fisher's Exact test, [c] Adjusted Chi-Square. Test statistics: Chi-Square value for categorical data, standardized Z value for Mann-Whitney U test, and *t* value for *t*-test.

of general profile distribution [13,14]. At the same time, our study was found to be compatible with studies in the literature in terms of complications observed after CABG operations (Table 1) [15–18].

In this study, firstly, we divided the SYNTAX 2 score into two groups, the low group and high group, according to the median value of 33. The difference between the low group and the high group in terms of age, gender, COPD, PAD, and kidney functions was statistically significant (Table 2). This statistical significance suggests that these parameters arise because they are components of the SYNTAX 2 score calculation algorithm. Türkoğlu *et al*. [19], they obtained similar results in their study on the 25 cut-off value of Syntax 2. Additionally, this is also study in the literature reporting that there may be a correlation between SYNTAX 2 score and PAD severity [20].

In the study published by Candemir *et al*. [21], 253 type 2 diabetes mellitus patients were included in the study and the patients were divided into three groups (low <22, medium 22–32, high >32) according to the SYNTAX score, and the relationship between the SYNTAX score and anthropometric measurements such as VAI and WC was evaluated. In this study, similar results to our study were obtained in terms of lipid profile and anthropometric measurements,

Table 4. Correlation analysis between SYNTAX 2 and VAI and demographic and postoperative data.

	r	*p*
SYNTAX 2		
Waist Circumference	0.081	0.290*
SYNTAX	0.282	<0.001*
BMI	–0.045	0.556#
VAI	0.047	0.540#
PoAF	0.021	0.784#
Respiratory Complications	0.104	0.175#
SWI	0.051	0.505#
Stroke	0.096	0.209#
LCO	0.139	0.068#
IABP	0.263	<0.001#
ICU Stay	0.364	<0.001#
Hospital Stay	0.355	<0.001#
VAI		
Waist Circumference	0.229	0.002*
SYNTAX	–0.080	0.292*
BMI	0.266	<0.001#
SYNTAX 2	0.047	0.540#
PoAF	–0.006	0.940#
Respiratory Complications	0.160	0.035#
SWI	0.129	0.090#
Stroke	–0.083	0.280#
LCO	–0.013	0.867#
IABP	–0.127	0.096#
ICU Stay	0.179	0.018#
Hospital Stay	0.134	0.079#

BMI, Body Mass Index.

* Pearson Correlation Test, # Spearman Correlation Test.

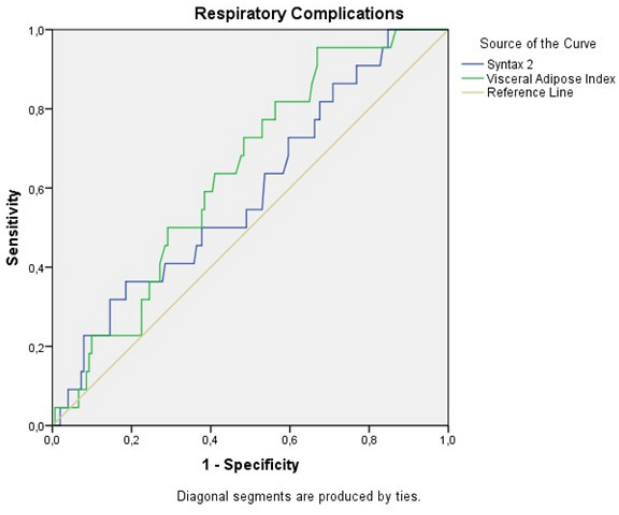

Fig. 1. Receiver operating characteristics curve for predicting respiratory complications.

and VAI values were observed to be higher in the group with a high SYNTAX score, and these results were found to be statistically significant ($p = 0.021$). As a result of our analysis, it was determined that VAI values were higher in the group with a higher SYNTAX 2 score, but no statistically significant difference was found ($p = 0.279$).

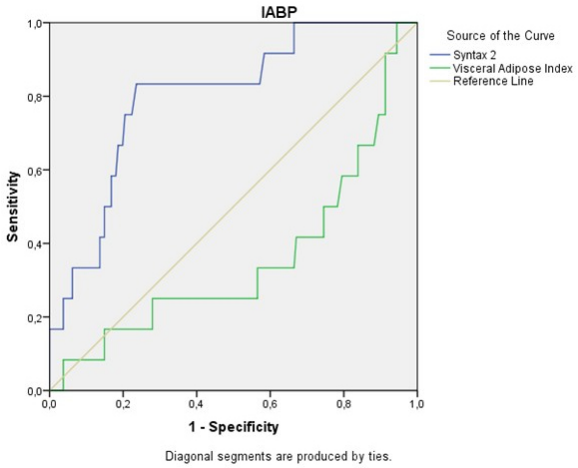

Fig. 2. Receiver operating characteristics curve for predicting intra-aortic balloon pump requirement.

VAI is an index created by mathematically formulating anthropometric parameters (WC, BMI) and certain laboratory values (triglyceride, high density lipoprotein (HDL) cholesterol). Additionally, prior study found a connection between VAT and several diseases, including vascular calcification, diabetes, hyperuricemia, metabolic syndrome, hypertension, and atherosclerosis [9]. According to Marco C. Amato *et al.*'s study [12], VAI is a useful measure of insulin sensitivity and "visceral adipose function", and its rise is strongly linked to cardiovascular metabolic risk. In a study conducted by Mohammadreza *et al.* [22], which included 6407 patients, the patients were divided into 5 groups according to their VAI values, and the analyses were applied separately to male and female gender groups. When the results of this study were evaluated, it was observed that, unlike our study, statistically significant data were obtained in the analysis made in terms of the prevalence of DM and the incidence of hypertension in the female gender group. It is well known that VAI is a factor highly associated with metabolic syndrome [23]. Considering that DM is an important component of metabolic syndrome, the results in this study are not surprising. Since our patients were included in the study due to surgically indicated CAD rather than metabolic syndrome, it is normal that similar data could not be obtained, especially in terms of DM. In another study conducted by Amato *et al.* [24], 1764 patients were divided into 4 groups according to their VAI values and evaluated in terms of DM, hypertension, advanced obesity, and metabolic syndrome, and statistically significant results were observed. In our study, no significant difference was found between VAI groups in terms of postoperative complications and mortality. Remarkably, respiratory complications and SWI are more common in the group with high VAI. There is no reference study investigating the

relationship between VAI and postoperative complications in patients undergoing CABG surgery, but there are many studies on obesity and high BMI values. In the study conducted by Birkmeyer *et al*. [25], the effects of obesity were evaluated in 11,101 patients who underwent isolated CABG surgery and they emphasized that obesity could be a predictor for SWI. In a similar study, Jin *et al*. [26], they divided 16,218 patients who underwent isolated CABG surgery into 6 groups according to their BMI values and evaluated them in terms of postoperative complications.

At the end of the study, they determined that obesity was a risk factor for deep sternal infection and that the duration of intensive care ventilation was prolonged in obese groups. Prolonged ventilation is a risk factor for postoperative respiratory complications. In our study, there was a significant difference in the length of stay in the ICU in the group with high VAI ($p = 0.008$). We also found a statistically significant correlation between VAI value and length of stay in the intensive care unit and respiratory complications ($p = 0.018$, $p = 0.035$, respectively). This can be explained by the fact that respiratory complications and SWI are more common in the group with high VAI, and these complications cause patients to be followed in intensive care for a longer time. Although there is no exemplary study in the literature examining VAI from this perspective, it would be useful to investigate the postoperative effects of VAI in patients undergoing CABG surgery, based on the results of our study.

Although our study was a prospective study, the number of patients was limited because it was conducted in a short time. The study may have insufficient statistical power, especially for subgroup analyses. Moreover, only early-term problems were evaluated in our study. It needs to be supported by multicenter, large-numbered prospective long-term studies. The European System for Cardiac Operative Risk Evaluation II and The Society of Thoracic Surgeons score, which are important risk scoring systems in cardiac surgery, could not be included in the analyses. These scores can also be compared in larger patient series.

Conclusions

In our study, no correlation was found between the SYNTAX 2 score and VAI. However, we found that high VAI can predict postoperative respiratory complications and has a positive correlation with prolonged ICU stay. It has been determined that a high SYNTAX 2 score could predict the need for IABP, and had a positive correlation with prolonged intensive care and hospital stay. Although it may seem more important to decide on coronary artery surgery and perform the surgery, being able to predict possible risks after surgery and take precautions is as important as the surgical procedure. With multicenter studies, VAI and SYNTAX 2 values may be included in preoperative risk assessment parameters. Therefore, measuring WC routinely preoperatively may be useful and guiding.

Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

Author Contributions

BD: Conceptualization, Data curation, Investigation, Methodology, Supervision, Validation, Visualization, Writing-original draft, Writing-review & editing; KKÖ, ME, USS, FT, SY: Conceptualization, Supervision, Validation, Visualization, Writing-original draft, Writing-review & editing. All authors have been involved in revising it critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

The study was approved by Bursa Yuksek Ihtisas Training and Research Hospital Clinical Research Ethics Committee (Approval number: 2011-KAEK-25 2023/07-02). Informed consent was obtained from all patients included in the study. All procedures were performed following the Declaration of Helsinki.

Acknowledgment

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

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