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ORIGINAL ARTICLE

A novel electrocardiographic parameter for the prediction of atrial fibrillation after coronary artery bypass graft surgery "P wave peak time"

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Abstract

Objectives Patients with postoperative atrial fibrillation (POAF) have increased risk of both short- and long-term mortality and morbidity; therefore, prediction of POAF is crucial in the preoperative period of the patients undergoing coronary artery bypass graft surgery. Electrocardiography (ECG) is the simplest and cost-effective tool in the preoperative workup of the patients for the prediction of POAF. A newly defined ECG parameter P wave peak time (PWPT) has been shown as a marker of atrial fibrillation development in non-surgical patients and we investigated its role in patients undergoing cardiac surgery.

Method A total of 327 patients undergoing isolated or combined cardiac surgery were involved and the primary endpoint was defined as the development of POAF. The study population was divided into two groups based on the presence or absence of POAF. Groups were compared for both standard P wave parameters and for PWPT on surface ECG. The predictors of POAF were assessed by multivariate regression analysis.

Results The frequency of POAF was 20.4% ($n=67$). P wave peak time in leads D2 (65.1 ± 11.8 vs 57.2 ± 10, $p<0.01$) and V1 (57.8 ± 18 vs 44.8 ± 12.3, $p<0.01$) were longer in patients with POAF. In multivariate regression analysis, PWPT in leads DII and V1 were independent predictors of POAF (OR: 1.11, 95%CI: 1.02–1.21, $p=0.01$, OR: 1.06, 95%CI: 1.00–1.13, $p=0.03$ respectively).

Conclusion PWPT in leads DII and V1 can predict the development of POAF in patients undergoing cardiac surgery.

Keywords Atrial fibrillation · Cardiac surgery · P wave peak time

Introduction

Atrial fibrillation (AF) is a common complication after cardiac surgery. The incidence of postoperative atrial fibrillation (POAF) varies between 25 and 50% depending on the differences in definitions, type of surgery, and mode of detection [1]. Unfortunately, improvements in surgical techniques or prophylactic treatments have not changed the frequency of POAF over decades [2] and POAF continues to be the cause of increased morbidity, mortality, and health care costs [3]. Furthermore, patients with POAF have increased risk for later atrial fibrillation development when compared with patients in sinus rhythm after surgery [4].

Atrial cardiomyopathy serves as a substrate for AF and includes structural and electrophysiological abnormalities of the atrium [5]. PR interval, P wave duration, P wave terminal force (PWTF), or other morphologic P wave parameters reflect underlying atrial remodeling and are associated with increased risk of AF in both surgical and non-surgical patients [6, 7]. A new ECG parameter, P wave peak time (PWPT), represents the prolonged intra-atrial and interatrial conduction time and recent data have shown a relationship with the development of AF [8].

Timely identification of patients at risk for developing AF preoperatively can facilitate implementing prophylactic treatments and consequently reduce the incidence of complications associated with AF. In this regard, our aim was to evaluate the predictive power of PWPT for the development of AF in patients undergoing cardiac surgery.

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Methods

Study design

After approval by the local ethics committee, patients with no previous diagnosis of AF, undergoing urgent or elective CABG with or without heart valve replacement/repair between June 2019 and January 2020, were included in this study. The primary outcome was the development of POAF due to CABG surgery. Patients with metabolic disorders, patients with electrolyte disturbances, patients using antiarrhythmic medications, or patients with pacemakers were excluded from the study. Surgical closure of left atrial appendage or surgical ablation was considered exclusion criteria. Patients in whom preoperative sinus rhythm ECG were not accessible or not high enough quality to interpret were excluded from the study.

Procedures were performed by two experienced operators with median sternotomy and standard surgical techniques. Use of internal mammarian artery graft (LIMA), intra-aortic balloon pump (IABP), and proceeding with off-pump surgery were left to discretion of the primary operator performing the procedures. Combined surgery was defined as any additional procedure combined with coronary artery bypass graft surgery mainly valve replacement or repair. All patients were under 100 mg aspirin therapy at the day of surgery. Angiotensin-converting enzyme (ACE) inhibitors or angiotensin receptor blockers (ARB), β-blockers, and statin therapy were continued to the day of the surgery. Patients underwent two-dimensional and Doppler echocardiographic evaluation before surgery by an experienced cardiologist using Vivid-6 (General Electric Company, Milwaukee, WI).

All ECG recordings were obtained within 30 days before surgery and the most recent ECG was analyzed. AF was characterized with unidentifiable P waves and irregular RR intervals in the surface ECG. POAF was defined as the arrhythmia which persisted more than ≥ 10 min and was self-terminated or required electrical/medical cardioversion [7]. All patients were monitored continuously during their time in the intensive care unit, and then, ECGs were performed daily and additionally when they had reported symptoms. AF detected after hospital discharge did not undertaken consideration.

ECG analysis

Each patient's records were taken using the standard 12 derivation surface ECG with a 10 mm/mV calibration and 25 mm/s sliding rate. All ECGs were downloaded in JPEG format from the hospital database and then uploaded to the EP Calipers software program. After magnifying the images adequately, all measurements were calculated by two cardiologists. Average of the values was used for comparison.

P wave parameters such as P wave maximum duration, P wave dispersion, PR interval, P wave terminal force, and recently defined PWPT were used in our study. The definitions of these parameters were as follows: (1) PR duration was defined as the time period between the onset of the P wave and the onset of the QRS complex, (2) P wave maximum duration was measured from the beginning to the end of the P wave in all 12 leads on the surface ECG and the longest one acquired, (3) P wave dispersion was defined as the time difference in milliseconds (msc) between the longest and the shortest P wave duration in any of the standard ECG leads, (4) PWPT was measured from the beginning of the P wave deflection to the peak of the P wave in leads DII and V1. PWPT was defined as the time period between the starting point of the positive deflection and the top of the negative deflection when P waves were biphasic in lead V1. Negative waves which were ≥ 0.1 Mv in lead V1 accepted as biphasic and measurements were performed only in these patients, (5) P wave terminal force (PWTF) was calculated by multiplying the depth and the duration of the terminal negative component of the P wave in lead V1 and abnormal PWTF was defined as PWTF ≥ 40 mm X msc. Examples of PWPT measurements are shown in Fig. 1. The QRS duration was defined as the interval from the beginning of the QRS complex to the J point, and the longest duration was recorded. QT interval was the interval beginning from the QRS complex to the end of the T wave on the surface ECG and corrected QT was calculated by Bazett formula. ST segment depression ≥ 1 mm in at least two contiguous leads was included regarding ST segment deviation.

Statistics

Patients were separated into two groups according to the presence of POAF. All data were presented as a mean ± standard deviation (SD) for variables with normal distribution or a median [inter-quantile range] for variables with non-normal distribution. Categorical variables were reported as numbers and percentages. Continuous variables were checked for the normal distribution assumption using


A B

Fig. 1 P wave peak time measurements in leads DII (**A**) and V1 (**B**) the Kolmogorov–Smirnov statistics. Categorical variables were tested by Pearson's χ^2 test and Fisher's exact test. Differences between POAF (+) and POAF (-) groups were evaluated using the Mann–Whitney *U* test or the Student *t*-test, when appropriate. Univariable and multivariable binary logistic regression analyses were performed to investigate the independent correlates of POAF. As the result of the univariable regression analyses, variables which have *p* values < 0.10 were included in the multivariable regression analyses. Receiver operating curves were generated to define AUC and cutoff values of P wave indices for POAF. *p* values were two-sided and values < 0.05 were considered statistically significant. The ROC curves of the P wave indices were compared using MEDCALC software program (Softwarebvba 13, Ostend, Belgium). All statistical studies were carried out using Statistical Package for Social Sciences software (SPSS 22.0 for Windows, SPSS Inc., Chicago, IL).

Results

A total of 412 records were reviewed. In twenty-nine records, the rhythm was AF. Fifty patients did not have preoperative ECG and two patients underwent concomitant maze procedure. An additional 4 preoperative ECGs showed pace rhythm. After this exclusion, the study protocol was consisted of 327 subjects (Fig. 2).

Patients without previous AF diagnosis who underwent cardiac surgery entered the study (mean age = 61.5 ± 8.7, 64% men). POAF was seen in 67 patients (20.4%). Patients with POAF were older (68.1 ± 7.2 vs 59.8 ± 8.2, $p < 0.01$) and were less frequently on beta blocker therapy (25.4% vs 63.5%, $p < 0.01$). A total of 38 patients underwent combined surgery, where 20 of them had aortic valve surgery and the remaining patients had mitral valve surgery. POAF patients had higher frequency of combined surgery (22.4% vs 8.8%, $p = 0.02$) and larger LA diameters (40.6 ± 6.4 vs 36.2 ± 6.2, $p < 0.01$) compared with patients without POAF. Length of hospital stay after surgery was significantly longer (8 [2.0] vs 7 [2.0], $p < 0.01$) in patients who developed POAF. Baseline demographic, clinical, operative, and laboratory findings are provided in Tables 1 and 2.

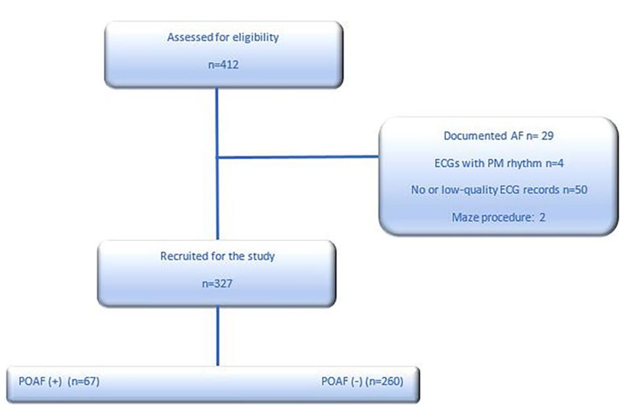

Fig. 2 Flow diagram of the study population

ECG parameters other than P wave indices were similar between the groups as shown in Table 3. P wave peak time in leads D2 (65.1 ± 11.8 vs 57.2 ± 10 $p < 0.01$) and V1 (57.8 ± 18 vs 44.8 ± 12.3 $p < 0.01$) were longer in patients with POAF. POAF patients had longer PR duration (171 ± 29.7 vs 157.8 ± 29.3, $p = 0.01$) and P wave dispersion (51.4 ± 18.3 vs 45.3 ± 16.3, $p < 0.01$) when compared with patients without POAF. Abnormal PWTF in lead V1 was more frequent in POAF patients (44.7% vs 37.3%, $p = 0.03$).

In multivariate regression analysis, age (OR: 1.14, 95%CI: 1.01–1.29, $p = 0.03$), LA diameter (OR: 1.35, 95%CI: 1.10–1.67, $p < 0.01$), PWPTD2 (OR: 1.11, 95%CI: 1.02–1.21, $p = 0.01$), PWPTV1 (OR: 1.06, 95%CI: 1.00–1.13, $p = 0.03$), PWTFV1 > 40 mm x msc (OR: 1.06, 95%CI: 1.00–1.11) were found to be independent predictors of POAF (Table 4).

We had also checked tolerance and variance inflation factor (VIF) for all parameters included in the regression model in order to prevent multicollinearity. According to the multicollinearity statistic, the tolerance values were > 0.1 and VIF values were < 10 for all parameters. Therefore, we determined that there was no multicollinearity between each of the variables in the regression model.

In ROC analysis, PWPTD2 ≥ 60.5 msc predicted POAF development with a sensitivity of 75% and a specificity of 69% (AUC: 0.71, $p < 0.01$) and PWPTV1 ≥ 45.5 msc predicted POAF development with a sensitivity of 73% and a specificity of 56% (AUC: 0.70, $p < 0.01$). These data are demonstrated in Fig. 3.

Occurrence of AF was highest in the second postoperative day (52%) and 85% of incident AF occurred during the first 3 days. Seven patients required direct current cardioversion and 47 patients received amiodarone therapy to convert to sinus rhythm. The remaining events were self-terminated or controlled with rate-lowering drugs only.

Discussion

To our knowledge, the present study is the first to assess the role of the PWPT in predicting the POAF in patients undergoing coronary artery bypass grafting (CABG). The main new finding of the present study was that PWPTD2 and PWPTV1 were independent predictors of POAF. Age, LA diameter, and PWTFV1 > 40 mm X msc were additional independent predictors of POAF. In addition, PWPTD2 ≥ 60.5 msc had a sensitivity of 75% and specificity of 69% with an AUC of 0.71 and PWPTV1 ≥ 45.5 msc

Table 1 Demographic, clinical, echocardiographic, and operative characteristics of patients. *ACEi*, angiotensinogen-converting enzyme inhibitor; *ARB*, angiotensin receptor blocker; *CVA*, cerebrovascular accident; *IABP*, intra-aortic balloon pump; *ICU*, intensive care unit; *LAAPD*, left atrium antero-posterior diameter; *RBC*, red blood cell; *sPAP*, systolic pulmonary artery pressure

Characteristics	Overall (*n* = 327)	POAF (+) (*n* = 67)	POAF (-) (*n* = 260)	*p* value
Demographics				
Age, median years	61.5 ± 8.7	68.1 ± 7.2	59.8 ± 8.2	**<0.01**
Males, *n* (%)	268 (63.6%)	60 (89.6%)	208 (80.8%)	0.07
Medical history				
Hypertension, *n* (%)	198 (60.6%)	41 (61.2%)	157 (60.4%)	0.90
Diabetes mellitus, *n* (%)	166 (50.8%)	29 (43.3%)	137 (52.2%)	0.17
Hyperlipidemia, *n* (%)	73 (22.3%)	21 (31.3%)	52 (20%)	0.06
Current smoker, *n* (%)	140 (42.8%)	33 (49.3%)	107 (41.2%)	0.23
Previous revascularization, *n* (%)	68 (20.8%)	11 (16.4%)	57 (21.9%)	0.32
Stroke, *n* (%)	17 (5.2%)	5 (7.5%)	12 (4.6%)	0.34
Chronic renal failure, *n* (%)	41 (12.5%)	10 (14.9%)	31 (11.9%)	0.50
Chronic lung disease, *n* (%)	16 (4.9%)	2 (3%)	14 (5.4%)	0.41
Peripheral arterial disease, *n* (%)	36 (11%)	8 (11.9%)	28 (10.8%)	0.36
Preoperative status				
Preop β-blocker use, *n* (%)	182 (55.7%)	17 (25.4%)	165 (63.5%)	**<0.01**
Preop ACEi use, *n* (%)	115 (35.2%)	25 (37.3%)	90 (34.6%)	0.68
Preop ARB use, *n* (%)	24 (7.3%)	2 (3%)	22 (8.5%)	0.12
Preop statin use, *n* (%)	116 (35.5%)	14 (20.9%)	102 (39.2%)	**0.05**
Acute coronary syndrome, *n* (%)	81 (24.8%)	13 (19.4%)	68 (26.2%)	0.25
Emergency surgery, *n* (%)	8 (2.4%)	2 (3%)	6 (2.3%)	0.74
Operative measures				
LIMA use, *n* (%)	289 (88.4%)	58 (86.6%)	231 (88.8%)	0.60
IABP support, *n* (%)	17 (5.2%)	5 (7.5%)	23 (8.8%)	0.34
Off-pump surgery, *n* (%)	9 (2.8%)	4 (6%)	5 (1.9%)	0.07
Combined surgery, *n* (%)	38 (11.6%)	15 (22.4%)	23 (8.8%)	**0.02**
Inotrope use, *n* (%)	31 (9.5%)	8 (11.9%)	23 (8.8%)	0.44
≥ 5 U RBC transfusion, *n* (%)	43 (13.1%)	9 (13.4%)	34 (13.1%)	0.93
Echocardiography				
Ejection fraction %	53.5 ± 8.7	54.2 ± 8.2	53.4 ± 8.9	0.63
LAAPD mm	37.1 ± 6.5	40.6 ± 6.4	36.2 ± 6.2	**<0.01**
Aorta mm	34.2 ± 4.4	34.9 ± 4.6	33.9 ± 4.3	0.18
sPAP mmHg	25.5 ± 9.0	26.8 ± 11.3	25.2 ± 9.6	0.12

had a sensitivity of 73% and a specificity of 56% with an AUC of 0.70 for predicting POAF.

In the past, atrial fibrillation after cardiac surgery was believed to be a benign arrhythmia presumably as a consequence of its self-limiting feature with a median duration of 48 h; however, recent studies and meta-analyses have shown a clear association between POAF and increased short-term mortality and morbidity [3, 9, 10]. Ghurram et al. have shown that ventilator hours, length of ICU stay, and length of hospital stay were significantly increased in patients who developed POAF after off-pump CABG [11]. Furthermore, POAF was associated with an increased risk of long-term mortality and stroke [12–17]. After understanding the adverse outcomes of POAF, it has become more important to identify the patients most vulnerable to AF following cardiac surgery. For this purpose, the researchers have recently focused on predictive indicators of POAF which may be briefly classified into three main categories as follows: clinical variables, the ECG and echocardiographic parameters. The preoperative ECG is probably the most useful and easily performed diagnostic technique available for the prediction of POAF.

Dispersion of atrial refractoriness is essential for induction of atrial arrhythmias. Many previous clinical studies have suggested that atrial fibrillation was closely associated with an atrial structural substrate which might be a source for dispersion of atrial refractoriness [18, 19]. In patients with POAF, atrial ischemia is obviously a major contributor to the development of atrial substrate. Several perioperative factors such as volume overload, electrolyte disturbances,

Table 2 Comparison of laboratory parameters between POAF (+) and POAF (-) groups. *HDL*, high-density lipoprotein; *hs-CRP*, high sensitive C-reactive protein; *e-GFR*, estimated glomerular filtration rate; *LDL*, low-density lipoprotein; *NT-pro BNP*, brain natriuretic peptide; *TSH*, thyroid-stimulating hormone; *WBC*, white blood cell

Laboratory parameters	Overall (*n* = 327)	POAF (+) (*n* = 67)	POAF (-) (*n* = 260)	*p* value
WBC 10^3 /µl	10.7 [4.75]	11.3 [7.9]	10.5 [4.4]	0.66
Hemoglobin g/dl	13 ± 2.1	13.3 ± 1.9	12.9 ± 2.1	0.19
Platelet 10^3 /µl	232.3 ± 72.5	228.1 ± 76.8	233.4 ± 73.5	0.59
Glucose mg/dl	142.1 [65]	143.4 [67.2]	141.9 [64.1]	0.86
Aspartate aminotransferase IU/l	28.6 ± 9.0	30 ± 9.2	28.3 ± 9.1	0.60
Alanine aminotransferase IU/l	27.8 ± 11.1	29 ± 10.8	27.5 ± 11.9	0.59
Sodium mEq/l	138.9 ± 2.5	139.4 ± 2.2	138.8 ± 2.5	0.10
Potassium mEq/l	4.3 ± 0.4	4.4 ± 0.4	4.3 ± 0.3	0.55
Hs-CRP mg/dl	0.3 [0.9]	0.4 [1.7]	0.3 [0.8]	0.33
c-Troponin-I ng/ml	0.04 [0.2]	0.02 [0.3]	0.02 [0.3]	0.20
e-GFR ml/dk/1.73m^2	83.8 ± 29.1	81.8 ± 18.4	84.3 ± 31.4	0.54
Total cholesterol mg/dl	198.9 ± 55.6	205.3 ± 45.8	197.2 ± 57.8	0.29
LDL cholesterol mg/dl	124.2 ± 44	127.1 ± 37.3	123.4 ± 45.7	0.54
HDL cholesterol mg/dl	40.7 ± 10	41.3 ± 9.2	40.6 ± 10.2	0.63
Triglyceride mg/dl	177.5 [98.5]	185.2 [104.5]	175.5 [119.4]	0.23
Uric acid mg/dl	5.3 ± 1.4	5.2 ± 1.2	5.4 ± 1.4	0.41
Calcium mg/dl	9.2 ± 0.6	9.1 ± 0.8	9.2 ± 0.6	0.18
Magnesium mg/dl	1.93 [0.3]	1.96 [0.2]	1.92 [0.3]	0.40
NT-pro BNP pg/ml	92 [109]	80 [63]	96 [111]	0.06
TSH µIU/ml	1.26 [1.1]	1.28 [1.1]	1.25 [1.2]	0.31

and hypoxemia have been associated with POAF in many previous studies [20, 21]. In addition, different surgical techniques have also been associated with the development of POAF [22–24]. On the other hand, multiple preoperative risk factors lead to left atrial structural changes and increase the likelihood of development of POAF. In a previous meta-analysis with a total number of 36,834 subjects, older age, increased LA diameter, lower EF, COPD, hypertension, MI, and diabetes were associated with increased POAF incidence [25].

The P wave on the ECG represents atrial depolarization and P wave abnormalities are associated with left atrial structural changes and conduction abnormalities. For this reason, preoperative ECG recordings, especially simple P wave changes indicative of LA abnormality, have been subjected to many previous studies to determine the predictors of POAF. P wave dispersion caused by inhomogeneous atrial conduction was identified as an independent predictor for the development of POAF [26]. P wave amplitudes in lead aVR and lead V1 have been described as powerful predictors

Table 3 Comparison of ECG findings between groups. *LAH*, left anterior hemiblock; *LPH*, left posterior hemiblock; *V1TF*, terminal force in lead V1

ECG findings	Overall (*n* = 327)	POAF (+) (*n* = 67)	POAF (-) (*n* = 260)	*p* value
P wave indices				
PR msc	160.6 ± 29.9	171 ± 29.7	157.8 ± 29.3	**0.01**
P wave maximum duration msc	121.7 ± 14.2	124.7 ± 18.1	120.9 ± 13	0.06
P wave dispersion msc	46.5 ± 15.9	51.4 ± 13.8	45.3 ± 16.3	**<0.01**
P wave peak time D2 msc	58.8 ± 10.9	65.1 ± 11.8	57.2 ± 10	**<0.01**
P wave peak time V1 msc	47.5 ± 14.6	57.8 ± 18	44.8 ± 12.3	**<0.01**
V1TF > 40 mm x msc, *n* (%)	127 (38.8%)	30 (44.7%)	97 (37.3%)	**0.03**
Other ECG parameters				
Heart rate bpm	73 ± 14.4	75.8 ± 14.4	71.8 ± 12.7	0.27
QRS msc	93.8 ± 20.7	95.5 ± 13.8	93.4 ± 22.2	0.44
cQT msc	419.8 ± 32.2	418.1 ± 34.8	418.1 ± 34.8	0.62
LAH, *n* (%)	30 (9.3%)	7 (10.4%)	23 (9%)	0.71
LPH, *n* (%)	5 (1.5%)	1 (1.5%)	4 (1.5%)	0.97
ST segment T wave changes, *n* (%)	102 (31.6%)	10 (14.9%)	42 (20%)	0.10

Table 4 Variables which were entered into multivariable regression model for predicting POAF after coronary artery bypass graft surgery in multivariable regression analysis

Variable	Adjusted OR (%95CI)	*p* value
Age years	1.14 (1.01–1.29)	**0.03***
LAAPD mm	1.35 (1.10–1.67)	**<0.01***
PWPTD2 msc	1.11 (1.02–1.21)	**0.01***
PWPTV1 msc	1.06 (1.00–1.13)	**0.03***
V1TF > 40 mm x msc, *n* (%)	1.06 (1.00–1.11)	**0.02***
P wave dispersion msc	1.00 (0.95–1.04)	0.92
Preoperative β-blocker use, *n* (%)	1.08 (1.05–1.11)	0.22
Combined surgery, *n* (%)	1.43 (0.18–10.9)	0.73

*Independent predictors of POAF after coronary artery bypass graft surgery

of POAF in a previous study [27]. Furthermore, in another study, three preoperative ECG characteristics were associated independently with POAF: premature atrial contraction, p wave frontal axis greater than 55°, and p wave index > 27 msc [28]. Besides these, a new scoring system has been proposed by Hayıroğlu and colleagues for the prediction of in-hospital and long-term AF development after ischemic stroke "morphology-voltage-P wave duration (MVP)" which reflects the prolonged inter- and intra-atrial conduction time as PWPT [29]. As a difference from these previous studies, for the first time in the literature, abnormal PWTF in lead V1 and PWPT in leads D2 and V1 have been found to be independent predictors of POAF in our study.

Recent studies have shown that PWPT is clearly associated with paroxysmal AF in both acute ischemic stroke patients [30] and the unselected population [8]. Yıldırım et al. have also found PWTF, a marker of a subclinical structural cardiac disease leading to left atrial volume overload, as an independent predictor of paroxysmal AF in the same unselected population [8]. It has been reported that PWPT was associated

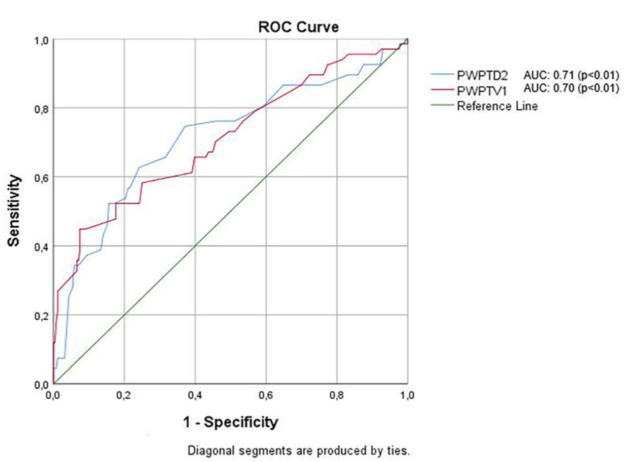

Fig. 3 ROC analysis of PWPT DII and PWPT V1

with the severity of CAD in patients with non-ST segment elevation myocardial infarction [31]. Çağdaş et al. have found that preprocedural PWPTD2 was an independent predictor of no-reflow [32]. Burak et al. have also suggested that PWPT in the lead DII may be an independent predictor of increased LVEDP among hypertensive patients [33].

PWPT, an easily obtainable and novel ECG parameter, represents the time taken for excitation spreading from sinoatrial node to the maximal summation of positive deflection from both atria. Prolonged P wave duration, indicating atrial conduction delay, is a potent precursor of atrial fibrillation. Atrial conduction delay and slowing of depolarization may prolong P wave duration and P wave reaches its maximum amplitude (PWPT) significantly later as a consequence of prolongation of P wave duration. Atrial ischemia and left atrial overload may even more deteriorate atrial depolarization and facilitate the development of POAF. Based on this information, we hypothesized that increased preoperative PWPT would be associated with POAF and our results have confirmed this assumption.

Conclusion

In conclusion, POAF is significantly associated with both short- and long-term adverse outcomes in patients undergoing CABG. The identification of patients at risk for POAF would be helpful to guide prophylactic therapy. Therefore, many researchers have focused on the prediction of POAF by using easily obtained and low-cost tools. Our study demonstrated that PWPTD2 and PWPTV1 are feasible and clinically applicable ECG parameters to predict POAF in patients treated with CABG. Further research is needed with a larger sample size to evaluate the role of PWPT as an independent predictor of POAF after cardiac surgery.

Limitations

This current study has several limitations. ECG recordings were taken daily after discharge from ICU where all patients were monitored continuously. Also, we were not able to perform rhythm Holter monitoring for AF detection. Due to these, possible brief episodes of AF might have been overlooked which can change the exact number of POAF patients. Additionally, we excluded AF patients based on preoperative ECG and medical history; however, we were not able to analyze paroxysmal episodes of AF before hospital admission which may interfere with our results. We were not able to evaluate the impact of several operative features for the development of POAF because of missing data. Finally, our study has the limitations of a single-center retrospective study with a small sample size.

Declarations

Ethics approval date and number 05.06.2020 – 28001928

Conflict of interest The authors declare no competing interests.

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