Predictive value of aortic knob width for postoperative atrial fibrillation in coronary artery bypass surgery

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Abstract

Objective: The aim of our study was determine whether aortic knob width (AKW) is associated with the development of atrial fibrillation (AF) after isolated coronary artery bypass surgery (CABG).
Methods: In this retrospective observational cohort study, we evaluated 135 patients without hemodynamically significant valvular problems. AKW was measured on chest X-ray by digital system. Multiple logistic regression analysis was used to find independent associates of postoperative AF (POAF). The diagnostic value of AKW was assessed using ROC analysis.
Results: POAF occurred in 43 (31.8%) of all patients. The age, AKW, left atrial (LA) diameter and C-reactive protein (CRP) were significantly higher in patients with POAF than without POAF (67.2±8.6 vs 61.3±9.8 years, p=0.004; 45.6±5.8 vs 36.1±3.8 mm, p<0.001; 37.9±3.5 vs 35.8±3.1mm, p=0.002 and 10.6±8.5 vs 5.6±6.5 mg/L, p=0.001 respectively). Multiple logistic regression analysis demonstrated that AKW, LA diameter and CRP were independently associated with POAF (OR=4.527, 95% CI=1.315 -15.588, p=0.017; OR=2.834, 95% CI=1.091-7.360, p=0.032 and OR=1.300, 95% CI=1.038-1.628, p=0.022 respectively). ROC analysis has demonstrated that aortic knob of 36.5 mm constitutes the cut-off value for the occurrence of POAF with 84.4% sensitivity and 64.6% specificity (AUC=0.84, 95% CI=0.75-0.94, p<0.001).
Conclusion: We have demonstrated a significant association between the AKW and AF development after isolated CABG. PA chest radiography is a cheap and readily available clinical tool and it can be examined easily by every cardiovascular surgeons.
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Key words: atrial fibrillation, aortic knob width, coronary artery bypass surgery, regression analysis, diagnostic accuracy

Introduction

Atrial fibrillation (AF) is a frequent complication following isolated coronary artery bypass grafting (CABG), with a rate of occurrence from 15 to 30% (1, 2). AF was initially thought to be harmless, but it is now known to predict hazardous postoperative conditions. Post-CABG AF could result in prolonged hospitalization and increased postoperative morbidity and mortality (3, 4). Detection of patients at high risk for developing postoperative AF should recover the efficacy of preventing adverse cardiovascular events.

The aortic knob width (AKW) is a radiographic configuration formed by a portion of the descending aorta and the foreshortened aortic arch. One study demonstrated that the AKW on a chest radiograph can provide important predictive information related to coronary atherosclerosis (5). In addition, aortic dilatation has been considered to be an indicator of the atherosclerotic process (6). Previous studies have identified associated risks for AF after CABG, such as age, ejection fraction, left atrium size, number of grafts, cardiopulmonary bypass, and cross-clamping time length (1, 6, 7).

To date, no study has examined the relationship between AKW and POAF development.

Therefore, we evaluated the relationship between AKW and POAF to determine whether an increased AKW can reflect AF after isolated CABG.

Methods

Study design

This study was designed as retrospective observational cohort study on diagnostic accuracy.

Study population

A total of 180 patients who underwent isolated CABG in Abant İzzet Baysal University Hospital between January 2009 and May

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2011 were evaluated in this study. Forty five patients were excluded from this study. The exclusion criteria were as follows: emergency surgery, repeat CABG, acute coronary syndrome, congestive heart failure, significant valvular heart disease, pacemaker implantation, atrial flutter or fibrillation, peripheral vascular diseases, pulmonary or neurological disease, pericarditis, congenital heart disease, overt hypothyroidism or hyperthyroidism, renal or hepatic disease, chest radiographs that were not properly centered and showed any deviation of the trachea or shift of the mediastinum, and any known disease such as aortitis.

Data collection

The patients baseline clinical, demographic and laboratory analysis including serum creatinine (mg/dL), total cholesterol (mg/dL), high-density lipoprotein cholesterol (mg/dL), low-density lipoprotein cholesterol (mg/dL) and C - reactive protein (CRP) (mg/L) were obtained from our laboratory records and patient files. In addition, patient's electrocardiography (ECG) records were obtained from patient files.

Peroperative assessment

We evaluated standard preoperative 12-lead ECGs recorded at a paper speed of 25 mm/s for each patient. All patients were operated by the same surgery and anesthesia team. All surgeries were underwent through median sternotomy, aortic cannulation, single right atrial cannula, with membrane oxygenator (DIDECO AVANT 903, ITALY), single cross clamp, initially anterograde via the aorta than retrograde blood cardioplegia every 15 min via the coronary sinus, a roller pump and mild systemic hypothermia (32-34°C). After CPB, heparin sodium was antagonized at the rate of 1mg heparin/1 mg protamine sulphate. The preferred inotropic agents were dopamine when than adrenaline, noradrenaline and intra -aortic balloon pump. The preferred vasodilator was nitroglycerin when necessary than sodium nitroprusside. All patients had monitored continuously by five-lead telemetry during the intensive care unit (ICU) admission and followed hourly with monitoring of blood gas samples. If the patient was electrolyte imbalance he immediately treated. Patients on preoperative beta- blockers continued to use them postoperatively to avoid withdrawal. AF was defined as an episode lasting for longer than 30 seconds irregular rhythm and not detected P waves. After ICU discharge, the patients were monitored continuously by five-lead telemetry and also daily by 12-lead electrocardiograms every morning. Additional electrocardiographic recordings were obtained from clinical records and patient's files whenever necessary or noticed by the nursing, patients reported palpitations.

Assessment of aortic knob width

Postero-anterior chest X-rays of all patients have obtained from our hospital records. An examiner who was unaware of the result of the patient's whether POAF or not reviewed the chest radiography by computer records. Examiner measured along the horizontal line from the point of the left lateral edge of the trachea to the left lateral wall of the aortic knob on computer records (Fig. 1).

Statistical analysis

Statistical analysis was performed by using SPSS 15.0 (SPSS Inc, Chicago, IL, USA) for Windows. Continuous variables are presented as mean±standard deviation (SD) and categorical values are presented as the percentage. An analysis of normality of the continuous variables was performed with the Kolmogorov-Smirnov test. Characteristics of the study groups were compared with independent t-test, Mann-Whitney U test and chi-square test. The Pearson correlation analysis was used for assessing correlation between age, CRP and AKW. Multiple logistic regression analysis was performed in order to find independent associates of POAF, which incorporated variables with a p value of less than 0.1 (Table 1). ROC curve analysis was performed for evaluation of diagnostic accuracy of AKW in prediction of POAF. A p value of $\leq$0.05 was considered statistically significant.

Results

Patient's demographic and laboratory characteristics

Demographic and laboratory characteristics and surgical data of the patients were presented in Table 1. In total 135 patients were included in this study (mean age: 66.3±9.8 years, 94 men and 41 women). POAF occurred in 43 (31.8%) of all patients, of these, 69.7% (30) were men, 72.0% (31) had hypertension, 34.8% (15) had diabetes, 58.1% (25) was smoking, 37.2% (16) had history of MI. POAF was not observed in 91 patients (mean age: 61.3±9.8 years, 67 men and 25 women), of these, 72.8% (67) were men, 69.5% (64) had hypertension, 32.6% (30) had diabetes, 55.4% (51) was smoking, 35.8% (33) had history of MI.

The left ventricular ejection fraction (LVEF) was significantly lower in patients with POAF than without POAF (p=0.008). Beta-blocker usage was slightly significantly lower in patients with POAF than without POAF (p=0.049).

The age, AKW, LA (left atrial) diameter and CRP were significantly higher in patients with POAF than without POAF (p=0.004, p<0.001, p=0.002 and p=0.001, respectively).

However, there were no significant differences in gender, diabetes, smoking, preoperative creatinine, heart rate, history of MI, number of anastomosis, need for inotropic support, statin therapies, use of angiotensin converting enzyme inhibitors or angiotensin receptors blockers between patients with POAF and without POAF.

Correlation analysis demonstrated that AKW was positively and significantly correlated with age and CRP levels (r=0.318, p<0.001 and r=0.214, p=0.013). But, there was no correlation between AKW and LVEF (r=-0.171, p=0.097).

Diagnostic value of AKW in prediction of POAF

The multiple logistic regression analysis (independent variables-age, beta blocker usage, LVEF, LA diameter, CRP level and

Table 1. Baseline demographic and clinical characteristics of the study population

Variables	No POAF (n=92)	POAF (n=43)	*P
Age, years	61.3±9.8	67.2±8.6	0.004
Male gender n (%)	72.8 (67)	69.7 (30)	0.861
Hypertension n (%)	64 (69.5)	31 (72.0)	0.298
Diabetes mellitus n (%)	30 (32.6)	15 (34.8)	0.612
Smoking n (%)	51 (55.4)	25 (58.1)	0.848
History of MI n (%)	33 (35.8)	16 (37.2)	0.412
Beta-blocker usage n (%)	46 (50.0)	19 (44.1)	0.049
Statin therapies, n (%)	44 (47.8)	20 (46.5)	0.712
ACEI or ARB, n (%)	46 (50)	21 (48.8)	0.600
Heart rate, beats/min	72.8±16	74.1±17	0.152
LV ejection fraction, %	56.7±9.0	50.7±11.1	0.008
LA diameter, mm	35.8±3.1	37.9±3.5	0.002
Glucose, mg/dL	96.7±8.4	97.2±11.8	0.586
Creatinine, mg/dL	0.81±0.18	0.83±0.17	0.312
Total C, mg/dL	181±52	180±46	0.915
HDL-C, mg/dL	34.8±8.9	34.5±8.9	0.857
LDL-C, mg/dL	113±33	117±43	0.741
CRP, mg/L	5.6±6.5	10.6±8.5	0.001
CPBT, min	94±33	96±35	0.454
CCT, min	63±22	66±23	0.466
Number of anastomosis	2.9±1.5	3.5±1.4	0.139
Need for inotropic support, n (%)	15 (16.3)	9 (20.9)	0.534
AKW, mm	36.1±3.8	45.6±5.8	<0.001

Data are presented as mean±SD and number (percentage)
*Independent samples t-test, and Chi-square test
ACEI - angiotensin-converting enzyme inhibitor; AKW - aortic knob width; ARB - angiotensin receptor blocker; CCT - cross clamp time; CPBT - cardiopulmonary bypass time; HDL-C-high - density lipoprotein cholesterol; LA- left atrium; LDL-C-low - density lipoprotein cholesterol; LV - left ventricle; MI - myocardial infarction

AKW) demonstrated that AKW, LA diameter and CRP levels were independently associated with POAF (OR=4.527, 95% CI=1.315-15.588 p=0.017; OR=2.834, 95% CI=1.091-7.360, p=0.034; OR=1.300, 95%=1.038-1.628, p=0.022) (Table 2).

ROC analysis demonstrated that aortic knob of 36.5 mm constitutes the cut-off value for the prediction of POAF with 84.4% sensitivity and 64.6% specificity (AUC=0.84, 95% CI=0.75-0.94, p<0.001) (Fig. 2).

Discussion

The results of our study revealed that AKW, CRP, LA diameter, age, beta-blocker usage and LVEF was a significantly associated with POAF after isolated CABG. In addition, AKW, LA diameter and CRP were independently predictors for POAF. This clinical study indicating that the AKW measured on routine chest X-rays is a useful predictor of POAF.

Table 2. Logistic regression analysis: predictors of postoperative AF

Variables	Univariate		Multiple	
	Odds ratio (95% CI)	P	Odds ratio (95% CI)	P
Beta-blocker	2.134 (1.022-4.611)	0.043	1.103 (0.732-3.991)	0.077
LA diameter, mm	1.234 (1.084-1.660)	0.001	2.834 (1.091-7.360)	0.032
EF	0.940 (0.890-0.980)	0.011	0.919 (0.808-1.045)	0.197
CRP	1.095 (1.030-1.155)	0.001	1.300 (1.038-1.628)	0.022
Age	1.039 (1.031-1.150)	0.001	0.918 (0.746-1.131)	0.423
AKW	2.219 (1.662-2.961)	<0.001	4.527 (1.315-15.588)	0.017
Sex	0.925 (0.386-2.261)	0.864		
Hypertension	1.200 (0.512-3.870)	0.773		
BMI	0.894 (0.854-1.014)	0.787		
Smoking	0.917 (0.379-2.214)	0.846		
Total-cholesterol	1.000 (0.990-1.008)	0.911		
LDL-C	1.007 (0.995-1.010)	0.755		
HDL-C	0.994 (0.961-1.054)	0.554		
Triglycerides	1.011 (0.997-1.020)	0.239		
ACEI/ARB	1.217 (0.584-2.519)	0.597		
Statin	0.884 (0.426-1.287)	0.740		

ACEI - angiotensin-converting enzyme inhibitor; AKW - aortic knob width; ARB-angiotensin receptor blocker; BMI - body mass index; CRP - C-reactive protein; EF - ejection fraction; HDL-C-high-density lipoprotein cholesterol; LA - left atrium; LDL-C-low-density lipoprotein cholesterol

Aging is associated with long-standing hypertension, aneurysmal changes of the aorta, and aortic dilatation; thus, the aorta is usually more dilated and more tortuous with increasing age (5). Sawabe et al. (8) evaluated 833 consecutive autopsy cases (community deaths) and found a simple correlation between age and aortic circumference. Yun et al. (5) measured the AKW and assessed the presence of aortic knob calcification via a chest postero-anterior view in 178 consecutive patients. They showed that the AKW was significantly correlated with the severity of coronary artery disease. Erkan et al. (9). have demonstrated significant association between AKW and carotid intima-media thickness, which is increasingly used as a surrogate marker for

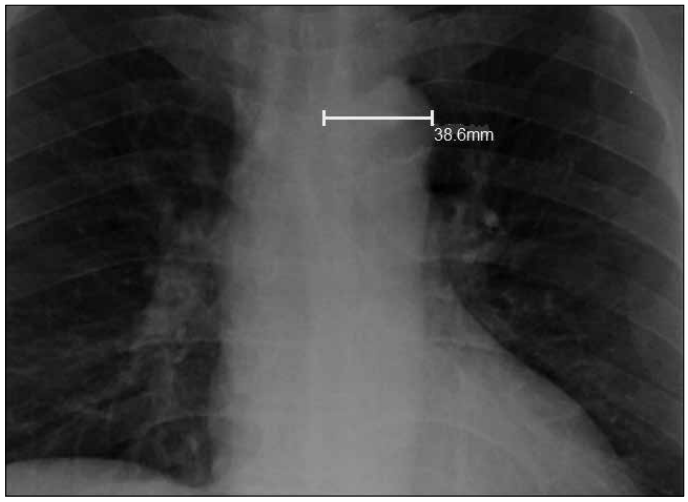

Figure 1. The aortic knob width on postero-anterior chest X-ray film

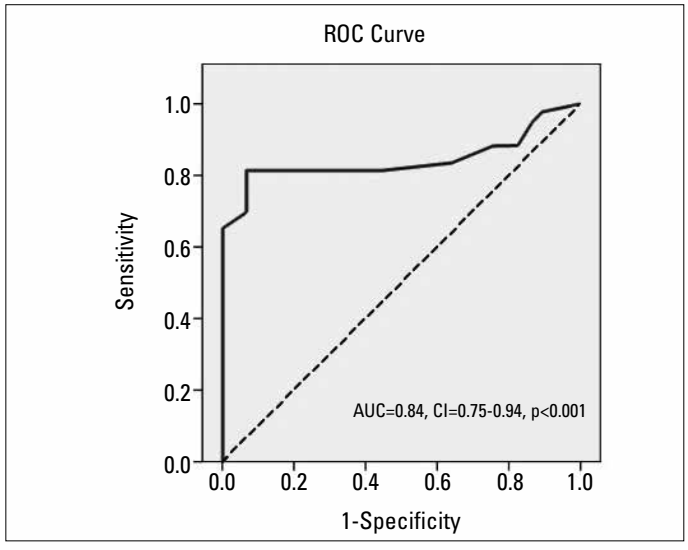

Figure 2. ROC analysis of diagnostic accuracy of AKW in prediction of postoperative atrial fibrillation in coronary artery bypass surgery (AUC=0.84, 95% CI=0.75-0.94, p < 0.001)
AKW - aortic knob width

atherosclerosis, in hypertensive patients having at least one cardiovascular risk factor. In another study, Korkmaz et al. (10) demonstrated that an AKW of 41 mm constitutes the cut-off value for the presence of subclinical atherosclerosis with 71% sensitivity and 77% specificity. Also, in a multicenter study, Mathew et al. (11) demonstrated that moderate or severe aortic atherosclerosis was a significant predictor of atrial fibrillation among postoperative patients. Our study was the first to evaluate the AKW as a possible predictor of the development of POAF after CABG and the first to demonstrate that an AKW of 36.5 mm constitutes the cut-off value for the occurrence of POAF with 84.4% sensitivity and 64.6% specificity. We considered that increasing AKW, correlated with CRP and age, may be a useful measure to predict POAF in the preoperative period. This correlation can be explained by inflammatory basis of the both conditions.

So far, many studies of postoperative AF have been done and described that predictors of postoperative AF were older age, ejection fraction, left atrial enlargement, aortic atherosclerosis and others (11-13). Similarly, in our study demonstrated that age were significantly higher in patients with POAF than without POAF. Also we found that the age was a predictor of POAF in univariate analysis. Açıl et al. (14) of the echocardiographic variables, only left atrial diameter was identified as a significant predictor of POAF. In the present study, we demonstrated that LA diameter, and low LVEF were significantly higher in patients with POAF than without POAF. Also, both of them were predictors of POAF in univariate analysis. However, we found that only LA diameter were independently associated with POAF.

To date, few studies have evaluated the relationship between postoperative AF and preoperative inflammatory markers including CRP. Moreover, some studies demonstrated that high CRP levels was independent predictor for POAF in patients undergoing CABG (15, 16). The present study, we found that the preoperative CRP significantly higher in patients with POAF than without POAF and was independent predictor for POAF. Also, we found that was a positive correlation between CRP and AKW. As well as, we found AKW was a predictor of POAF. This result may be a common cause of inflammation.

Study limitations

Firstly, this study is its retrospective design and relatively low number of patients. In addition, our results and conclusions are limited to new onset in-hospital AF and do not address episodes of AF that occurred after discharge. Although the AKW in our study was highly significant, the overall accuracy of the prediction was moderate (AUC=0.84). Another limitation of our study is that the population comprised patients who underwent isolated CABG. Therefore, the results may not be extrapolated to patients undergoing concomitant cardiac or extracardiac procedures.

Conclusion

We have demonstrated a significant association between the AKW and AF development after isolated CABG. Postero-anterior chest radiography is a cheap and readily available clinical tool, and it can be easily performed and evaluated by cardiovascular surgeons.

Conflict of interest: None declared.

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