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CLINICAL STUDY

Mitral annular plane systolic excursion (MAPSE) as a predictor of atrial fibrillation development after coronary artery bypass surgery

Cemal KOSEOGLU[1], Can Ramazan ONCEL[1], Goksel DAGASAN[1], Ali CONER[1], Ozgur AKKAYA[2]

Alanya Alaaddin Keykubat University, Faculty of Medicine, Department of Cardiology, Antalya, Turkey.
r_oncel@hotmail.com

ABSTRACT

OBJECTIVE:To predict the possibility of postoperative atrial fibrillation (AF) with mitral annular plane systolic excursion (MAPSE) measurement, which is a cheap, reproducible echocardiographic method and to monitor these patients more closely and to evaluate them more effectively postoperatively.

MATERIAL AND METHODS: 247 patients scheduled for coronary artery bypass surgery were evaluated and 200 patients were included in the study.The enrolled patients were classified into the two groups according to the occurrence of postoperative AF or maintained sinus rhythm after coronary artery bypass surgery (normal sinus rhythm [NSR] group vs. AF group).The clinical and demographic data of all the patients were recorded on admission. Two-dimensional transthoracic echocardiography (TTE) was performed prior to elective surgery.

RESULTS:Postoperative new onset AF occurred in 37 (18.5%) patients. In the multivariate logistic regression analysis carried out after the formation of the model based on the parameters related to AF development, the relationships with white blood cell count, LAd and MAPSE were observed to be prevalent.When MAPSE, which is a parameter used to predict the development of postoperative atrial fibrillation, was compared in the ROC analysis, the area under the curve was found to be 0.831, 95% CI lower-95% CI upper (0.761-0.901) ($p<0.001$). The distinguishing MAPSE value in predicting postoperative atrial fibrillation development was found to be 11.6 (sensitivity: 90%, specificity: 81%).

CONCLUSIONS: We showed that MAPSE could play a role in determining postoperative atrial fibrillation development after coronary artery bypass surgery *(Tab. 2, Fig. 2, Ref. 28)*. Text in PDF www.elis.sk

KEY WORDS: atrial fibrillation, coronary artery bypass surgery, mitral annular plane systolic excursion.

Introduction

With the development of surgical procedures, coronary artery bypass grafting (CABG) has emerged as a successful procedure for coronary revascularization. However, the advancement of monitoring systems and the admission of severely ill and elderly patients have led to a paradoxical increase in the occurrence of atrial fibrillation (AF) in recent years (1) The most common result following CABG is AF, which has been reported in the literature to occur at a rate of 20% to 40% (2). The occurrence of AF following CABG is noteworthy because of the increased risk of embolism, post-operative hemodynamic instability, and extended hospital stay (3–6). The underlying cause of AF after CABG is complex and not fully understood.

Mitral Annular Plane Systolic Excursion (MAPSE) is a rapid and repeatable echocardiographic test that shows the left ventricle's longitudinal function and seems to be a helpful early indicator of left ventricular function (7). Diastolic dysfunction of the left ventricle is likewise linked to low MAPSE levels (8). In addition, MAPSE has been shown to be a potent prognostic factor in AF, heart failure, and post-myocardial infarction (7–10). MAPSE was found to be a predictor of AF recurrence after pulmonary vein isolation by Alatic et al (11). Borde et al investigated the efficacy of MAPSE in predicting left ventricular diastolic dysfunction after off-pump CABG (12).

Research in the literature has attempted to identify the various factors that are useful in predicting AF following CABG, including hypertension, age, gender, and male status; right coronary artery stenosis; chronic obstructive pulmonary disease; prior history of AF; duration of the electrocardiographic p-wave; left atrial diameter; and left ventricular ejection fraction (13–15). The aim of our study is to predict the possibility of postoperative AF development with MAPSE measurement,

[1]Alanya Alaaddin Keykubat University, Faculty of Medicine, Department of Cardiology, Antalya, Turkey, and [2]Alanya Alaaddin Keykubat University, Faculty of Medicine, Department of Cardiovascular Surgery, Antalya, Turkey

Address for correspondence: Can Ramazan ONCEL, Alanya Alaaddin Keykubat University, Faculty of Medicine, Department of Cardiology, Antalya, Turkey.
Phone: +905063715199

which is a cheap, reproducible method that does not require much operator experience.

Material and methods

Patients and study design

The data of 200 patients who underwent cardiopulmonary bypass with isolated CABG between 2022 and 2023 were examined in this study. Our study was approved by Alanya Alaaddin Keykubat University Clinical Research Ethics Committee.

Patients between the ages of 18 and 80, scheduled for isolated elective CABG with sinus rhythm were included in the study. Patients with moderate-severe valvular disease, prior heart surgery, heart failure (low left ventricular ejection fraction <35%), >8 segmental wall activity abnormality, paroxysmal atrial fibrillation, left atrial enlargement (LA>45 mm), preoperative supraventricular tachyarrhythmia, systemic or metabolic diseases that could affect the study results, patients with malignancy, acute-chronic infectious disease, chronic kidney disease (serum cr>2.0 mg /dl or GFR<60 ml/dk), were excluded from the study.

In total, 247 patients were evaluated in this study, and 200 patients met the study criteria. Twelve patients with poor image quality, five patients with moderate-severe valvular heart disease, thirteen patients who had left ventricular dysfunction before the operation were not included in the study.

The clinical and demographic data of all the patients were recorded on admission. Two dimensional transthoracic echocardiography (TTE) was performed prior to elective surgery. Transthoracic echocardiographic studies were performed using a 2.5–3.5 MHz transducer (ie33, Philips Medical System, Bothell, Washington, USA). The examinations were performed by a cardiologist who was blinded to the patients' clinical and demographic status. The echocardiographic examination was performed according to the guidelines of American Society of Echocardiography. The Teicholtz formula was used to calculate the left ventricular ejection fraction.

Mitral annular plane systolic excursion (MAPSE) measurement

While right ventricular dysfunction can affect the measurement of septal MAPSE, lateral MAPSE is more sensitive and specific for measuring the global longitudinal function of the LV. Mitral annular plane systolic excursion can be measured from the septal, lateral, anterior, and posterior walls using M-mode echocardiography in apical four and two chamber views (Fig. 1). Because the LV apex is immobile, the atrioventricular plane moves towards the apex, producing left ventricular longitudinal pump function. It evaluates LV longitudinal shortening in normal people, which is a sensitive characteristic that is known to represent the LV systolic function. Additionally, longitudinal shortening is thought to be the main factor influencing the LV net pump function. Reduced MAPSE has been reported to be a sensitive indicator of left ventricular dysfunction in a number of clinical contexts. This value is less dependent on the quality of 2D images and provides a high temporal resolution. Using transthoracic echocardiography (TTE), the typical range of MAPSE is 12±2 mm (7).

Surgical technique

The patients underwent on-pump CABG surgery using a conventional technique. To summarize, after a median sternotomy, the ascending aorta was cannulated for the arterial line and a single-stage venous cannula was inserted via the right atrial auricle. Aortic root venting and cold crystalloid cardioplegia were administered via the antegrade route. Cardiopulmonary bypass (CPB) with moderate systemic hypothermia (30–32°C) and hemodilution (Hct>0.22) was the technique used. Antegrade cold crystalloid cardioplegia was administered sporadically to each subject. Peripheral and central anastomoses were created as a result of a single aortic blockage. The bypass conduits were either the saphenous veins, the internal mammary artery, or both.

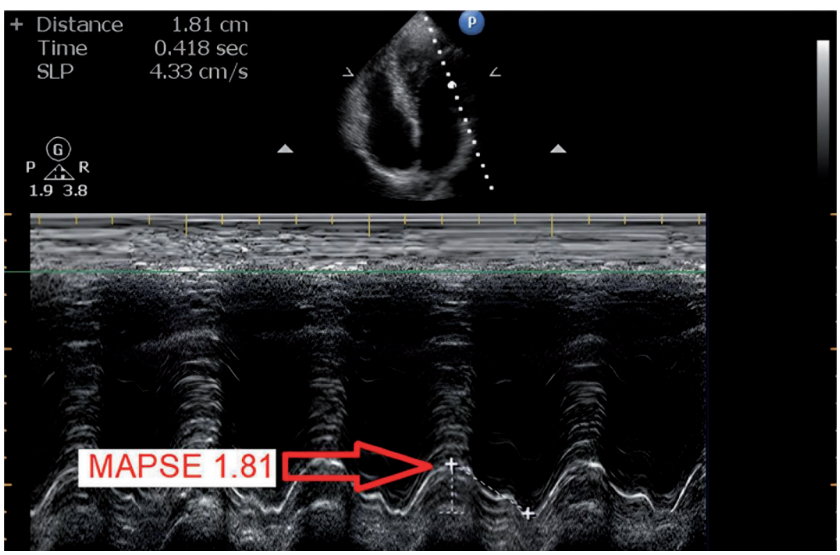

Fig. 1. Measurement of the mitral annular plane systolic excursion (MAPSE). MAPSE was measured at the septal side (A) and the lateral side (B) of the atrioventricular plane by M-Mode and the average value was calculated.

Postoperative follow-ups

We monitored the patients while they were in the hospital, keeping in mind that the risk of atrial fibrillation after surgery rises about 48 hours after the procedure. We analyzed ECG readings, in-hospital progress notes, nursing charts, discharge notes, and replies for cardiologist consultation in addition to using postoperative diagnosis based on the International Classification of Diseases-10 categories. We also noted patients with postoperative atrial fibrillation who needed electrical cardioversion for rhythm or rate control, or who needed intravenous antiarrhythmic medication such as amiodarone, beta blockers, propafenone, diltiazem, or verapamil.

Statistical analysis

The normal distribution was evaluated using the Kolmogorov–Smirnov test. Categorical variables were identified using numbers and percentages, whereas continuous variables were expressed using mean±standard deviation (SD). Continuous variables were compared using either a oneway analysis of variance (ANOVA) or the Student's t-test. The chi-square technique was employed to assess the differences in distributions of categorical variables. In this inquiry, the Bonferroni multiple comparison test was employed to effectively manage type I error for all possible multiple comparisons.

The forward elimination strategy using default values was used to identify prognostic factors. In the context of the Bonferroni multiple comparison test, statistical significance was determined by a p value below 0.025. The application of the forward LR method in multiple logistic regression analysis allowed for the identification of the most influential factors in determining the postoperative atrial fibrillation. All variables that had a p value less than 0.25 in the univariable test were considered as potential candidates for the multivariable model, along with other variables of acknowledged clinical importance. In addition, we calculated 95% confidence intervals (CIs) and adjusted odds ratios. The receiver operating characteristic (ROC) was utilized to illustrate the cut-off value of MAPSE for accurately predicting the postoperative atrial fibrillation. The results were considered significant if the p value was less than 0.05. The investigation was carried out utilizing the 27th iteration of the Statistical Package for the Social Sciences (SPSS).

Results

The enrolled patients were classified into the two groups according to the occurrence of postoperative AF or maintained sinus rhythm after coronary artery bypass surgery (normal sinus rhythm (NSR) group vs. AF group). Postoperative new onset AF occurred in 37 (18.5%) patients. Baseline demographic and clinical characteristics of the study subjects are shown in Table 1.

When the demographic, clinical and echocardiographic data of the groups are evaluated, the age (p=0.81), male sex (p=0.34), and the BMI (p=0.9), LVEF (p=0.19), LAd (p=0.42) values were observed to be same between two groups. Also, no difference was observed in terms of the ACE/ARB use between the patients in whom SR was maintained, and in whom the AF developed (p=0.63). In the group where AF was observed to develop, the MAPSE was lower than in those where NSR was maintained (p=0.03). White blood cell count, left atrial diameter (LAd), MAPSE and statin use were found to be independent risk factors in predicting postoperative AF (p<0.001, p<0.001, p=0.001, p=0.002, respectively)

In the multivariate logistic regression analysis carried out after the formation of the model based on the parameters related to AF development, the relationships with white blood cell count, LAd and MAPSE were observed to be prevalent.

When MAPSE, which is a parameter used to predict the development of postoperative atrial fibrillation, was compared in the ROC analysis, the area under the curve was found to be 0.831, 95% CI lower-95% CI upper (0.761–0.901) (p<0.001).The distinguishing MAPSE value in predicting postoperative atrial fibrillation development was found to be 11.6 (sensitivity: 90%, specificity: 81%) (Fig. 2).

Discussion

In our study, we investigated whether MAPSE has any role in predicting AF after CABG. We found that the MAPSE decreased

Tab. 1. Baseline demographic and clinical characteristics of the study subjects.

Demografic parameters	AF, n (37)	NSR, n (163)	p
Age (mean ±SD, years)	66.4±7.1	62±6.5	0.81
Male gender, n (%)	26	99	0.34
Hypertension, n (%)	12	64	0.44
Diabetes mellitus, n (%)	9	38	0.89
COPD, n (%)	3	16	0.74
Smoking history, n (%)	15	68	0.74
Coronary artery disease, n (%)			0.26
Stable	10	74	
Unstable	8	17	
Non ST elevation MI	19	72	
Body mass index (kg/m^2)	28.2±1.9	27.9±2.0	0.9
Dyslipidemia	20	93	0.71
hematologic			
Hemoglobin (g/dl)	11.5±0.7	11.5±0.6	0.47
White blood cell (x10^{3}xµg)	9.3±0.7	8.8±0.7	0.67
Creatinin (mg/dl)	1.03±0.07	0.96±0.14	0.26
Sodium (mEq/L)	137.2±1.5	138.4±1.6	0.35
LDL (mg/dL)	141±15	137±21	0.27
Echocardiographic parameters			
Left atrium (mm)	38.2±2.6	34.6±2.6	0.42
LVDD (mm)	44.5±7.0	44.8±4.9	0.39
LVSD (mm)	28.4±4.9	26.7±1.4	0.12
Preoperatif LVEF (%)	63.0±2.2	62.2±2	0.19
MAPSE (mm)	11.57±1.26	13.74±2.11	**0.03**
Mild mitral regurgitation	14	37	0.16
Medications			
ACEI/ARB (%)	7	27	0.63
SS-Bloker (%)	10	93	0.51
Statin (%)	9	87	**0.04**
İnotrop use (%)	8	21	0.17
Operation			
Pump time (min)	96.5±4.5	90.0±5.2	0.33
Aortic cross-clamp time (min)	56.0±3.1	48.3±5.4	0.09
Number of grafts used,			0.11
LIMA	3	26	
2 vessel	8	17	
≥ 3 vesel	26	120	

COPD – chronic pulmonary disease, LDL – low density lipoprotein, LVDD – left ventricular end-diastolic diameter, LVSD – left ventricular end-systolic diameter, LVEF – left ventricular ejection fraction, MAPSE – mitral annular plane systolic excursion, ACEI – angiotensin converting enyzme inhibitor, ARB – angiotensin receptor blocker

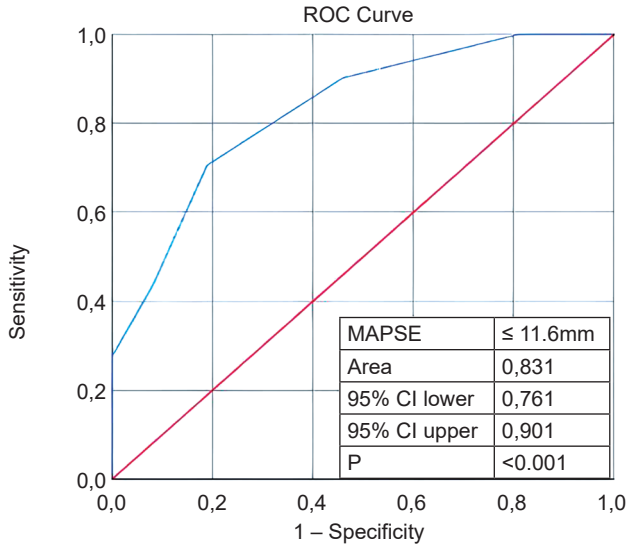

Fig. 2. ROC curves generated to evaluate MAPSE as predictor of postoperative atrial fibrillation development.

more in patients with AF after CABG. We also demonstrated that MAPSE≤11.6 mm was a risk factor for AF, and patients after CABG who had MAPSE≤11.6 mm had a 6-fold increased risk of having CAD. MAPSE≤11.6 mm had a 90% sensivity and 81% specifity in predicting AF.

Despite advanced surgical techniques and preventive treatments, the most common complication after CABG is atrial fibrillation (3). The importance of preventing post-operative atrial fibrillation is associated with an increase in the frequency of thromboembolic events, deterioration of hemodynamics, and an increase in hospitalization time (16, 17). The incidence of postoperative AF has been reported to be 10–40% (18). We also found postoperative AF in 18.5% in our study. Many preventive treatments have been researched to prevent the development of postoperative atrial fibrillation and there are studies on beta-adrenergic receptor antagonists, calcium channel blockers, amiadaron, sotalol, prapofenone that may be effective (17, 19, 20). Nomani et al also found that statin

Tab. 2. Multivariate logistic regression analysis of atrial fibrillation after CABG.

	Odds ratio	95% CI	p
Male gender, n (%)	0.604	0.302–1.416	0.28
Hypertension, n (%)	1.347	0.632–2.871	0.440
copd, n (%)	1.234	0.340–4.474	0.740
White blood cell (x10^3xμg)	2.733	1.603–4.657	**<0.001**
Heamoglobin (g/dl)	0.981	0.588–1.637	0.670
B blocker use (%)	1.301	0.587–2.884	0.510
Statin (%)	1.112	0.821–1.407	**0.002**
Pump time (min)	1.300	1.180–1.426	0.112
Aocrossclamptime (min)	1.338	1.213–1.476	0.072
PreoEF (%)	1.216	1.017–1.455	0.320
Left atrium (mm)	1.610	1.361–1.904	**<0.001**
MAPSE (mm)	0.363	0.246–0.536	**0.001**

COPD – chronic pulmonary disease, LVEF – left ventricular ejection fraction, MAPSE – mitral annular plane systolic excursion

treatment reduced the risk of postoperative AF secondary to its anti-inflammatory effect (21). In our study, we found that the risk of AF development was lower in patients using statins.

Some parameters have been suggested in the literature to predict postoperative AF. Gorczyca et al stated that the reason that the risk of postoperative AF increases the most is age. Age-related changes in the cardiac conduction system were found to substantially contribute to arrhythmia in post-CABG patients (22) We also found a similar increase in the risk of postoperative AF with increasing age. Haghjoo et al found age, left atrial diameter, abnormal P wave morphology, and right coronary artery graft failure to be associated with postoperative AF (23). Mendes et al found a relationship between severe right coronary artery stenosis and the frequency of postoperative AF (24), and we did not reach a conclusion that supports Mendes et al The reason for this situation may be the limited number of our patients. In our study, wbc, left atrial width, MAPSE and statin use were found to be independent risk factors for predicting postoperative AF.

MAPSE is the measurement of the movement of the mitral annulus, which is formed by two different structures such as the left atrium and the left ventricle, towards the left ventricular apex in systole by echocardiographic m-mode method. It clinically demonstrates the longitudinal function of the left ventricle (7) MAPSE predicts cardiac mortality in patients with chronic atrial fibrillation, as demonstrated by Rydberg et al. The diagnostic utility of MAPSE for heart failure with preserved ejection fraction was substantiated by Wenzelburger et al (25, 26).

Dagmar et al found a relationship between decreased MAPSE values and LV diastolic dysfunction (8). Borde et al demonstrated the usefulness of MAPSE in demonstrating LV systolic dysfunction after off pump CABG (27). The relationship between LV dysfunction and the development of AF has been previously shown in the literature (28). In patients with atrial fibrillation receiving catheter ablation (CA), lower mitral annular plane systolic excursion (MAPSE) and greater left atrial volume index (LAVI) are risk factors for AF recurrence after CA determined by Alatic et al (11). In the light of all this information, we investigated the usefulness of MAPSE in predicting postoperative AF in our study. Our research revealed that the optimal threshold value of MAPSE to predict post operative AF was ≤11.6 mm and a reduction in MAPSE by 11.6 resulted in a six-fold increase in a probability of AF. Also we found that wbc, left atrial width, statin use and decrease in MAPSE value are independent risk factors for the development of postoperative AF, in addition MAPSE is the most effective in predicting the risk of developing postoperative AF. Contrary to the literature, we did not find a correlation between hypertension and postoperative AF (16). The limited number of patients and the fact that it was a single-center study may be the reason for this difference.

Conclusion

The aim of our study is to predict the possibility of postoperative AF with MAPSE measurement, which is a cheap, reproducible method that does not require much operator experience, and to

monitor these patients more closely and to evaluate them more effectively in terms of preventive drug therapy.

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