Echocardiographic predictors of atrial fibrillation after mitral valve replacement

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Postoperative atrial fibrillation (POAF) is the most common arrhythmia after cardiac surgery, with an incidence of 33% to 49% (1). POAF is considered benign and without serious consequences, but it is associated with increased early and late mortality after mitral valve replacement (2).

Most studies have focused on POAF after coronary artery bypass grafting (CABG) or aortic valve replacement. Thus emerged the importance of detecting the incidence and determinants of atrial fibrillation (AF) after mitral valve surgery.

The aim was to detect the echocardiographic predictors of POAF in patients with rheumatic mitral valve disease undergoing mitral valve replacement. It was single center, prospective, clinical trial that was conducted from August 2015 to May 2016. The study included 50 patients (after excluding 21 patients) with rheumatic mitral valve disease and sinus rhythm who were eligible for mitral valve replacement. Consent from the patients and approval from Ethical Committee were obtained. Exclusion criteria included patients with comorbidities precluding cardiac surgery, permanent AF or history of paroxysmal AF, impaired left ventricular (LV) systolic function, associated aortic valve disease necessitating concomitant aortic valve replacement, congenital heart disease, concomitant CABG, prior cardiac surgery, and patient refusal. Preoperative assessment included taking thorough history, clinical evaluation and calculation of Society of Thoracic Surgeons (STS) score, standard 2-dimensional echocardiography transthoracic echocardiogram to assess LA diameter, volume, emptying fraction, and LV volume and ejection fraction. Tissue Doppler imaging (TDI) was used to determine velocity and strain of the LA as well as for speckle tracking to assess LV function and in postoperative follow-up for 1 month for occurrence of atrial fibrillation. Preoperative clinical characteristics of patients are shown in Table 1.

During first 30 days postoperative, 22 patients (44%) developed AF (Group 1) and 28 (56%) patients remained in sinus rhythm (Group 2). Patients who developed AF included 9 (40.91%) patients with paroxysmal AF and 6 (27.27%) patients with persistent AF. Group 1 patients were significantly older (53.32±6.9 years vs. 46.78±6.49 years; p=0.001), a finding consistent with previous reports by Osranek et al. (3). Diabetes mellitus (59.09% vs. 14.29%; p=0.001), hypertension (50% vs. 17.86%; p=0.001), and statin usage (27.27% vs. 0%; p=0.005) were more prevalent in Group 1. Beta-blocker usage (31.82% vs. 78.57%; p=0.001) was lower in Group 1 (Table 1).

Patients who developed AF had significantly greater body mass index (29.54±0.71 vs. 28.07± 0.68; p<0.001), diastolic blood pressure (BP) (72.5±7.2 mm Hg vs. 68.17±5.49 mm Hg; p=0.02) and heart rate (78.64±7.27 bpm vs. 73.5±4.94 bpm; p=0.004). Thirty-four patients had mitral stenosis and 15 of them developed POAF; 16 patients had mitral regurgitation and 7 of that group developed POAF.

LA diameters (anteroposterior, transverse, and longitudinal) were greater in Group 1 (4.84±0.17 cm vs. 4.51±0.09 cm, 4.61±0.13 cm vs. 4.35±0.11 cm, and 6.13±0.25 cm vs. 5.39±0.18 cm, respectively; p<0.001), a finding consistent with Kernis et al. (4). LA volumes (maximal and minimal) were significantly greater in Group 1 (103.68±3.66 mL vs. 93.23±3.96 mL and 66.18±7.85 mL vs. 54.9±3.25 mL, respectively; p<0.001). This is consistent with Haffajee et al. (5), who reported that indexed maximal (p=0.023) and minimal (p<0.001) LA volumes were greater in patients who developed postoperative AF. There was no significant statistical difference between the 2 groups with regard to LA emptying fraction (37.04±7.74% vs. 40.47±5.39%; p=0.08).

Group 1 had significantly reduced LV ejection fraction (53.77±7.71% vs. 62.37±2.2%; p<0.001) and higher pulmonary

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Table 1. Baseline demographic & clinical data of the studied groups

Variable	Overall patients	Group 1 POAF (n=22)	Group 2 No POAF (n=28)	P
Age (Mean±SD)	49.66±7.37	53.32±6.9	46.78±6.49	0.001
Gender				
Male	18 (36%)	7 (31.82%)	11 (43.33%)	0.4
Female	32 (64%)	15 (68.18%)	17 (56.67%)	
Comorbidities				
Diabetes mellitus	17 (34%)	13 (59.09%)	4 (14.29%)	0.001
Hypertension	16 (32%)	11 (50%)	5 (17.86%)	0.02
Dyslipidemia	15 (30%)	10 (45.45%)	5 (17.86%)	0.03
Patients' clinical data				
Heart rate, bpm	75.67±6.4	78.64±7.27	73.5±4.94	0.004
SBP, mm Hg	112.11±9.92	113.41±11.06	111.17±9.07	0.43
DBP, mm Hg	70±6.57	72.5±7.2	68.17±5.49	0.02
BMI, kg/m^2	28.71±1.01	29.54±0.71	28.07±0.68	<0.001
Medications				
Beta-blockers	29 (58%)	7 (31.82%)	22 (78.57%)	0.001
ACE inhibitors	11 (22%)	6 (27.27%)	5 (17.86%)	0.5
Statins	6 (12%)	6 (27.27%)	0 (0%)	0.005

BMI - body mass index; DBP - diastolic blood pressure; POAF - postoperative atrial fibrillation; SBP - systolic blood pressure. (t) Student's t-test; (χ^2) chi-square test; (FET) Fisher's exact test

artery systolic pressure (49.82±3.42 mm Hg vs. 47.9±1.9 mm Hg; p=0.01) (Table 2).

Group 1 showed significantly decreased early diastolic mitral annular velocity and late diastolic velocity (0.11±0.03 m/s vs. 0.14±0.02 m/s; p<0.001 and 0.76±0.07 m/s vs. 0.82±0.08 m/s; p=0.01, respectively). Ratio between early mitral inflow velocity and early diastolic velocity was significantly greater (9.84±2.15 vs. 6.19±1.16; p=0.001). There was no significant statistical difference with regard to systolic velocity (0.08±0.01 m/s vs. 0.08±0.01 m/s; p=0.08).

Group 1 had lower systolic LA strain (19.53±0.51% vs. 23.45±0.27%; p<0.001) (Table 2), a finding consistent with Candan et al. (6) and lower LV global longitudinal strain (LVGLS) (-14.27±1.61% vs. -20.25±1.02%; p<0.001).

STS score showed significantly increased risk of mortality and morbidity in Group 1 (2.08±0.76 vs. 0.89±0.16 and 26.94±6.38 vs. 12.32±3.2, respectively; p<0.001). Cardiopulmonary bypass time and cross-clamping time were significantly longer in Group 1 (137.68±10.91 min vs. 118.71±4.60 min and 79.27±17.2 min vs. 72.86±2.49 min, respectively; p<0.001). Ventilator time and duration in intensive care unit were also significantly longer (13.66±6.58 h vs. 6.59±0.44 h and 36.95±15.07 h vs. 23.1±0.99 h, respectively; p<0.001).

Multivariate logistic regression analysis revealed that preoperative clinical data associated with POAF were gender (p=0.059), beta-blocker use (p=0.006), heart rate (p=0.006), and diastolic BP (p=0.006) with area under curve (AUC) of 0.9659.

Table 2. Echocardiographic parameters of the studied groups

Variable	POAF (n=22)	No POAF (n=28)	P
Echocardiography			
LA anteroposterior diameter	4.84±0.17 cm	4.51±0.09 cm	<0.001
LA longitudinal diameter	6.13±0.25 cm	5.39±0.18 cm	<0.001
LA transverse diameter	4.61±0.13 cm	4.35±0.11 cm	<0.001
LA maximal volume	103.68±3.66 mL	93.23±3.96 mL	<0.001
LA minimal volume	66.18±7.85 mL	54.9±3.25 mL	<0.001
LA emptying fraction	37.04±7.74%	40.47±5.39%	0.08
LVESV	37.77±18.16 mL	25.5±1.04 mL	<0.001
LVEDV	78.91±22.94 mL	68.1±2.54 mL	1.00
LV EF	53.77±7.71%	62.37±2.2%	<0.001
PASP	49.82±3.42 mm Hg	47.9±1.9 mm Hg	0.01
TDI			
S	0.08±0.01 m/s	0.08±0.01 m/s	0.08
E'	0.11±0.03 m/s	0.14±0.02 m/s	<0.001
A'	0.76±0.07 m/s	0.82±0.08	0.01
E/E' ratio	9.84±2.15	6.19±1.16	<0.001
Systolic LA strain	19.53±0.51%	23.45±0.27%	<0.001
LV GLS	-14.27±1.61%	-20.25±1.02%	<0.001

A' - late diastolic velocity; E - early mitral inflow velocity; E' - mitral annular early diastolic velocity; LA - left atrium; LVEDV - left ventricular end diastolic volume; LVEF - left ventricular ejection fraction; LVESV - left ventricular end systolic volume; LVGLS - left ventricular global longitudinal strain; PASP - pulmonary artery systolic pressure; POAF - postoperative atrial fibrillation; S - systolic velocity; TDI - tissue Doppler image. (t) Student's t-test; (z) Mann-Whitney U test

Echocardiographic parameters associated with POAF were LA systolic strain (p<0.001) and LVGLS (p=0.003) with AUC of 0.9919, a finding consistent with Candan et al. (6).

Systolic LA strain ≤23 cm/s was demonstrated to have sensitivity of 90.91% and specificity of 93.33% in predicting presence of POAF with AUC of 0.9811 (95% confidence interval [CI], 0.952–1.01) and LVGLS ≤-14.9% had sensitivity of 63.6% and specificity of 100.0% in predicting presence of POAF with AUC of 0.8182 (95% CI, 0.71–0.92). Levy et al. (7) reported that LVGLS <-15% was associated with higher risk of POAF.

Therefore, we can conclude that LA systolic strain and LVGLS were significant predictors of POAF. Echocardiographic parameters can identify patients at greater risk of developing POAF who may benefit from preventive measures. It may also guide selection of prosthesis.

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