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CAN PREOPERATIVE LEFT ATRIAL MECHANICAL FUNCTION PREDICT THE RISK OF ATRIAL FIBRILLATION AFTER CARDIAC SURGERY?

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Abstract

Objectives: To examine whether the left atrial (LA) mechanical function is a predictor for the development of post-operative atrial fibrillation (POAF) following cardiac surgery.

Background: POAF is an important and frequent complication of cardiac surgery. The relationship between LA mechanical function and POAF is not well understood. We examined the relationship between pre-operative LA function and POAF in patients without a history of atrial fibrillation.

Method: our study was a prospective study that included 80 subjects who were eligible for cardiac surgery. pre-operative transthoracic echocardiograms were done for all subjects which were followed up for the occurrence of atrial fibrillation postoperatively. They were divided postoperatively into two groups. Group1: patients who developed POAF.group 2: patients who did not develop AF post operatively. The left atrial maximum volume and left atrial minimum volume were measured preoperatively and indexed to body surface area .LA TEF was calculated as: {[(LAVmax – LAVmin)/LAVmax] 100%}.

Results: POAF occurred in 35% of subjects. Mean LA TEF in group 1 was 43.43%±4.38 versus 56.48±6.20% in group 2. Mean LAVmaxI in group 1 was 32.40±4.97 ml/m^2 versus 26.66±6.26 ml/m^2 in group 2. Mean LAVminI in group 1 was 17.17±3.62 ml/m^2 versus 10.49±3.56ml/m^2. LA TEF was lower in patients with POAF compared with those without POAF (43 ± 4.38% vs. 56.48± 6.2%, p 0.000).

Conclusions: preoperative assessment of LA TEF is an independent predictor of POAF. Pre operative medical prophylaxis can be given to those with poor left atrial mechanical function.

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Key words: atrial, cardiac, fibrillation , function, procedures.

Introduction

One of the most frequent complications after cardiac surgery is atrial fibrillation [1]. Atrial fibrillation is defined as any irregular rhythm wirh fluctuating baseline and no definite P wave lasting ≥ 30 s during the postoperative period and required either pharmacologic or electrical cardioversion. It is the most common dysrrhymia in this setting leading to increased cardiovascular morbidity and mortality especially from thromboembolic events. It usually occurs in the immediate postoperative period leading to increased hospital stay and consequently increased finanacial burden [2].

The mechanism of this postoperative atrial fibrillation (POAF) may be attributed to `atrial fibrosis and remodeling together with other perioperative factors such as atrial injury, inflammation and electrolyte imbalance [3,4]. Unfortunately, it has been reported that patients who develop this complications have increased late mortality up to four years after surgery [5].

Multiple risk factors for post operative atrial fibrillation have been identified [6,7,8]. However there is no clear standard for predicting or preventing POAF. Left atrial size and left atrial maximum volume (LAVmax) have been identified as risk factors for the development of POAF, but the findings have been inconsistent [9,10]. Patients with high risk for Post operative atrial fibrillation can benefit from prophylactic therapy or even strict post operative monitoring

Left atrial mechanical function rather than left atrial volume determined by echocardiographic indices have been found to be a stronger risk factor for POAF [11]. In this study we echographically assesss the left atrial function determined by left atrial total emptying fraction (TEF) for patients undergoing open cardiac surgeries trying to know its relationship with postoperative atrial fibrillation. Predicting high risk patients for POAF by certain clinical and pre operative echocardiographic characteristics will help applying a prophylactic therapy to those patients.

The aim of the study was to examine whether the left atrial (LA) mechanical function is a predictor for the development of post-operative atrial fibrillation (POAF) following cardiac surgery.

Methods

Our study was a prospective study that was carried out in Menofia university hospitals and El Mahalla cardiac center from 1\1\2022 to 1\10\2022.

An informed consent was obtained from all participants.

We included adult patients more than 18 years old who had underwent elective open cardiac surgery. Diagnostic quality pre-operative transthoracic echocardiograms were done within 3 months before the operation. Those patients were prospectively identified and were followed up for the occurrence of POAF during the post-operative hospital course. The mean time between echocardiogram and surgery was 7 +- 20 days.

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We excluded all patients with cardiac rhythm other than sinus rhythm**,** patients who needed urgent cardiac surgery**,** patients with poor echocardiographic window and those refusing to participate in the study

Patients postoperatively were allocated to either group 1 or group 2.

Group 1 included patients who developed atrial fibrillation post operatively during their hospital stay while group 2 included patients who did not develop atrial fibrillation post operatively.

All patients were subjected to history taking, focusing on age and personal history (diabetes, hypertension, arrhythmia, valvular heart disease, uremia, hypo or hyperthyroidism and electrolyte disturbance

Complete drug history was also taken. Complete general and local physical examination were done. Electrocardiography was done (Philips Afiniti 70 G ,U.S.A) prior and after surgery. Laboratory investigations in the form of Complete blood count (Mindray BC-3000 plus,CHINA), PT, PTT, INR (Mindray C2000-2,CHINA), kidney function tests, Na, K and TSH(Golden berg 8, GERMANY) were performed.

Pre-operative echocardiograms(ECG model: 301, Medicare ,CHINA) were reviewed without knowledge of clinical data, and offline measurements of variables were performed according to established methods.

Measured echocardiography variables included: Pre-operative 2D echocardiograms were reviewed without knowledge of clinical data, and offline measurements of variables were performed according to established methods.

Measured variables included: diastolic and systolic ventricular chamber dimensions, interventricular septum and posterior wall thickness, maximum and minimum LA volumes, mitral E-wave and A-wave velocities, mitral E-wave deceleration time, average of tissue doppler septal and lateral mitral annulus early diastolic velocities (È), and average of tissue doppler septal and lateral mitral annulus late diastolic velocities (Á). Left ventricular mass was calculated and indexed to body surface area. Left ventricular ejection fraction was calculated.

Using the area-length method, LAVmax and LAV minimum were measured in 2 chamber and 4 chamber views of 2D echo and the mean of both measurments were taken. LAVmax and LAVmin were indexed to the body surface area. LA TEF was calculated as (LAVmax - LAVmin/LAVmax X 100)

POAF was defined as an episode of atrial fibrillation of any duration that occurred during the post-operative hospitalization and that required either pharmacologic or electrical intervention **[12].**

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 20. The qualitative data were presented as number and percentages while quantitative data were presented as mean, standard deviations and ranges when their distribution found parametric.

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The comparison between two groups with qualitative data were done by using *Chi-square test* and/or *Fisher exact test* was used instead of Chi-square test when the expected count in any cell was found less than 5.

The comparison between two independent groups with quantitative data and parametric distribution was done by using *Independent t-test.*

The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant if less than 0.05.

Results

Our study included 80 patients; 42 of them were males and 38 were females. Their ages ranged from 36 to 70 years; mean 60.29 with a mean BMI of 30.20±3.11. There were no statistically significant difference between Group I and Group II regarding Sex, Age and BMI (kg/m2). Regarding co morbidities; In Group I a 17.9% of them had Diabetes, 10.7% were Hypertensive, 21.4% were Smokers and 25.0% had dyslipidemia, while in Group II; 11.5% of them had Diabetes, 9.6% had Hypertension, 21.2% were Smokers and 32.7% had dyslipidemia. There were no statistically significant difference between Group I and Group II regarding Diabetes, Hypertension, Smoking and Hyperlipidemia.

Regarding the indications of surgery; In Group I; 17.9% of them were AVR, 25.0% were CABG, 0.0% were DVR, 21.4% were DVR & T repair, 28.6% were MV Repair and 7.1% were MVR&T repair, while the Group II; 19.2% of them were AVR, 32.7% were CABG, 11.5% were DVR, 5.8% were DVR & T repair, 26.9% were MV Repair and 3.8% were MVR&T repair. There were no statistically significant difference between Group I and Group II regarding Indication of surgery (Table 1).

By comparing group 1 and 2 regarding the body surface area (BSA) .There were statistically significant difference between Group I and Group II regarding BSA (m2) with an average BSA (m2) of 1.76 ± 0.31 in Group I, and 1.92 ± 0.29 in Group II(Table 1).

The average Hospital stay (days) in Group I were; 17.19 ± 3.26, while average Hospital stay (days) in Group II were 10.30 ± 2.91. There were highly significant difference between Group I and Group II regarding Hospital stay (days) (p value 0.001)(Table 1).

There were no statistically significant difference between Group I and Group II regarding POST LVEF (%),LVEDD (cm) and LV mass index (g/m2) (Table 1)**.** There were highly significant difference between Group I and Group II regarding PRE LVEF (%),LVESD (cm), LA length (cm), LAV maxI (mL/m2) and LAV minI (mL/m2) (table 1).

There were no statistically significant difference between Group I and Group II regarding A velocity (cm/s), E/A ratio, Mitral E′ velocity (cm/s), Mitral A′ velocity (cm/s) and Mitral S velocity (cm/s)(Table 2) and there were highly significant difference between Group I and Group II regarding LATEF (%),E velocity (cm/s), Mitral DT (ms), Mitral E/E′, PASP (Table 2)**.**

Discussion

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Echocardiography is a non-invasive diagnostic tool that can provide useful information about the function and anatomy of the cardiovascular system. [**13].** The aim of this study was to investigate the relationship between pre-operative left atrial mechanical function (LA TEF%) and postoperative atrial fibrillation (POAF) in patients undergoing elective cardiac surgery

Our study was a prospective study that was carried out in cardiovascular surgery department of Menofia university and El Mahalla cardiac center. Eighty patients postoperatively were allocated to either group 1 or group 2. **Group 1**: patients who developed atrial fibrillation post operatively during their hospital stay. **Group 2**: patients who did not develop atrial fibrillation post operatively.

The current study showed that, there were highly significant difference between Group I and Group II regarding LA length (cm) , LAV maxI, and LAV minI.

Many studies have reported LAV as a predictor of developing AF in a wide variety of patient populations, both with and without known cardiovascular disease [**14**]. In addition, LAV was a better measure of LA size than LA diameter, especially when it is enlarged, owing to its asymmetric enlargement. [**15].**

According to **Hidayet et al** [**16]** who studied predictors of POAF in patients undergoing elective CABG using preoperative three-dimensional echocardiography (3D ECHO). They reported that Vmax and Vmin were found to be higher in the POAF group. In their study, LAVI was found to be a strong predictor of POAF development in multiple regression analysis. **Osranek et al [17]** has reported that LAVmaxI can be used as an independent predictor of POAF and LAVmaxI > 32 mL/m2 was associated with a five-fold increased risk of POAF, independent of age or any other clinical risk factors in patients undergoing cardiac surgery.

Similarly, **Darweesh et al [11]** who reported that, LAVI was also associated with significantly increased risk of POAF in their patients.. In their study, Patients who developed POAF had reduced LA reservoir, conduit functions, and reduced booster pump function

Regarding the left atrium mechanical function, The present study revealed that, there were highly significant difference between Group I(43.43 ± 4.38 %) and Group II (56.48 ± 6.20%) regarding LATEF (%).

According to **Kievišas et al [18]**, LATEF was considered as a new echocardiographic marker that describes atrial remodelling more than does LA enlargement, and so it may be used to select patients at increased risk of developing POAF who might benefit from preoperative prophylaxis **.**

LATEF was a measure of global LA function (reservoir, conduit, and systolic booster functions) of the left atrium and reflects a later stage of atrial dysfunction than LA volume alone as it is associated with both LA mechanical and electrical dysfunction [**19].** This is in agreement with Haffajee et al. (2011)(12) who reported that POAF is associated with low LATEF. **Kislitsina et al [20]** reported that, the preoperative left

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atrial emptying fraction (LA-EF) was significantly lower in patients who developed POAF following CABG.

The current study showed that, there were no statistically significant difference between Group I and Group II regarding age. This in disagreement with **Darweesh et al [11]** who aimed to prospectively assess the importance of new echocardiographically derived risk factors and clinical related risk factors as a predictor of post-operative atrial fibrillation following cardiac surgery. They reported that Patients who developed POAF in their study were older (mean age 61 ± 5.89). Diabetes (DM) and poor glycaemic control are known to be associated with an increased risk of POAF **[21]**. However, in our study, there were no statistically significant difference between Group I and Group II regarding Diabetes, Hypertension, Smoking and Hyperlipidemia.This is in harmony with **Darweesh et al [11]**who reported that, there was no difference in incidence of POAF between diabetic patients (50%) and non-diabetic patients ($P = 0.147$).

In our study female were (35.7%) and the male were (64.3%) among the patients who developed atrial fibrillation post operatively.This is in accordance with **Vaporciyan et al [22**] who showed that male gender was correlated with the development of POAF in a large database of patients undergoing noncardiac thoracic surgery. Also, **Roselli et al [23**] found that male gender was correlated with POAF. While it was reported that, POAF was more often seen in females, especially those with a history of chronic heart failure **[24].**

Our study showed that, there were highly significant difference among Group I than Group II regarding Hospital stay (days). This is in accordance with **Darweesh et al** who reported that, patients who developed POAF had longer hospital stay (16.67 ± 4.59 vs 10.97 ± 2.46 days). This is mostly due to the association between AF and other co-morbidities, and due to the repeated attempts of either to restore sinus rhythm or to control heart rate and in order to begin and control anticoagulant therapy for those patients [**25].**

Conclusion

Pre-operative assessment of new echocardiographic markers of left atrial dysfunction has an incremental role as a predictor for POAF especially in patients undergoing cardiac surgery.

LATEF is an independent predictor of POAF, which can be easily calculated from 2-dimensional transthoracic echocardiography, may be a useful method for pre-operatively identifying patients with impaired LA mechanical function who are most likely to benefit from prophylaxis for POAF.

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Table (1): Comparison between Group I and Group II regarding Hospital stay (days), PRE LVEF (%),POST LVEF (%),LVEDD (cm), LVESD (cm), LV mass index (g/m2), LA length (cm), LAV maxI (mL/m2) and LAV minI (mL/m2).

		Group I	Group II	Test value•	P-value
		No. = 28	No. = 52		
Hospital stay (days)	Mean ± SD Range	17.19 ± 3.26 13 – 25	10.30 ± 2.91 6 – 15	9.673*	0.001
PRE LVEF (%)	Mean ± SD Range	51.05 ± 8.67 40 – 65	59.12 ± 5.79 50 – 70	-4.972*	0.001
POST LVEF (%)	Mean ± SD Range	65.71 ± 4.41 58 – 74	67.13 ± 4.36 58 – 77	-1.385	0.170
LVEDD (cm)	Mean ± SD Range	5.54 ± 0.54 4.6 – 6.2	5.38 ± 0.82 4 – 6.5	0.936	0.352
LVESD (cm)	Mean ± SD Range	4.07 ± 0.70 3 – 5	3.63 ± 0.69 2.5 – 4.5	2.692*	0.009
LV mass index (g/m2)	Mean ± SD Range	108.74 ± 17.66 85 – 135	108.07 ± 14.56 85 – 130	0.183	0.856
LA length (cm)	Mean ± SD Range	4.33 ± 0.60 3 – 5	3.95 ± 0.59 3 – 5	2.771*	0.007
LAV maxI (mL/m2)	Mean ± SD Range	32.40 ± 4.97 25 – 40	26.66 ± 6.26 16 – 35	4.181*	0.001
LAV minI (mL/m2)	Mean ± SD Range	17.17 ± 3.62 12 – 24	10.49 ± 3.56 5 – 16	7.955*	0.001

Signifigant*

Table (2): *Comparison between Group I and Group II regarding* LATEF (%),E velocity (cm/s), A velocity (cm/s), E/A ratio, Mitral DT (ms), Mitral E′ velocity (cm/s), Mitral A′ velocity (cm/s), Mitral S velocity (cm/s), Mitral E/E′, PASP and LATEF.

		Group I	Group II	Test value•	P-.value
		No. = 28	No. = 52		
LATEF (%)	Mean ± SD Range	43.43 ± 4.38 35 – 50	56.48 ± 6.20 45 – 65	-9.887*	0.001
E velocity (cm/s)	Mean ± SD Range	85.93 ± 16.68 60 – 115	67.24 ± 10.94 50 – 85	6.036*	0.001

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A velocity (cm/s)	Mean ± SD Range	78.62 ± 11.80 55 – 100	75.35 ± 11.79 58 – 95	1.181	0.241
E/A ratio	Mean ± SD Range	1.11 ± 0.28 0.71 – 1.59	1.10 ± 0.29 0.5 – 1.5	0.074	0.942
Mitral DT (ms)	Mean ± SD	169.18 ± 32.42	231.67 ± 33.43	-8.058*	0.001
Mitral E′ velocity (cm/s)	Mean ± SD	8.12 ± 1.06	8.65 ± 1.65	-1.527	0.131
Mitral A′ velocity (cm/s)	Mean ± SD	11.79 ± 2.05	12.00 ± 1.96	-0.456	0.650
Mitral S velocity (cm/s)	Mean ± SD	9.61 ± 2.45	9.90 ± 3.02	-0.433	0.666
Mitral E/E′	Mean ± SD	12.67 ± 2.54	7.75 ± 2.21	9.005*	0.001
PASP	Mean ± SD	43.63 ± 6.51	28.07 ± 4.71	12.284*	0.001

Significant*