

Echocardiographic Predictors of Atrial Fibrillation after Coronary Artery Bypass Grafting: A Speckle Tracking Echocardiography Study

Bassam S Hennawy^{1,*}, Karim Mounir Kamel², Ahmed Mohammed Onsy¹, Ahmed Mohammed Abd-Elsalam¹

¹Cardiology Department, Faculty of Medicine, Ain Shams University, Cairo, Egypt

²National Heart Institute, Cairo, Egypt

*Correspondence should be addressed to Bassam Sobhy Hennawy, bassam.sobhy@med.asu.edu.eg

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Abstract

Background: Following both cardiothoracic and non-cardiothoracic surgery, postoperative atrial fibrillation (POAF), is frequently observed. Up to 5–40% of patients have been reported to have atrial fibrillation (AF) in the initial postoperative phase after coronary artery bypass grafting (CABG). Early AF detection would help with prevention and allow for appropriate medication treatment.

Aim of the study: To identify the function of speckle tracking echocardiography (STE) in the prognostication of atrial fibrillation following isolated CABG in ischemic patients.

Patients and methods: One hundred forty patients with sinus rhythm and ischemic heart disease were scheduled for CABG as part of this prospective study. The patients received the appropriate clinical evaluation, electrocardiogram, and echocardiogram (STE, tissue doppler, and conventional).

Results: Of all the patients in this study, 45 (group A) developed atrial fibrillation, whereas 95 (group B) maintained sinus rhythm. Regarding the patients' risk factors (age, diabetes, hypertension, dyslipidemia, and smoking) and echocardiographic measures (LV volumes and ejection fraction, E/E ratio, LA strain, and LV global longitudinal strain), there was no remarkable difference between the two groups. P-values of 0.582 and 0.599, respectively, indicate that the mean LA strain in group A was $21.418 \pm 1.617\%$ vs $21.197 \pm 1.668\%$ in group B whereas the mean LV global longitudinal strain was $-16.868 \pm 3.607\%$ in group A and $-17.285 \pm 3.175\%$ in group B.

Conclusion: Speckle tracking and other echocardiographic measures were not able to predict the incidence of POAF.

Keywords: Speckle tracking, Postoperative atrial fibrillation, Coronary artery bypass grafting

Introduction

The most prevalent major arrhythmia, atrial fibrillation (AF), is causing major morbidity and mortality throughout any population. AF patients have longer hospital admissions, a higher risk of death, and worse outcomes than stroke patients without AF. Chronic AF makes a stroke more likely. Moreover, it may result in additional serious side effects such as hemodynamic disturbance, heart failure, and even death [1].

The most seen complication after cardiac surgical procedures is AF after cardiac surgery (AFACS), affecting 20–25% of patients after isolated coronary artery bypass grafting (CABG),

30% after isolated valvular procedures, and 40–50% after mixed CABG/valvular procedures [2].

Most patients who develop postoperative AF do not have a history of arrhythmias [3].

Early risk assessment for AF might help with prevention and allow for appropriate medication to be administered beforehand. Most often, an episode of AF happens two or three days following CABG. Seventy percent of individuals acquire cardiac arrhythmia before the end of post-operative day [4].

The best time to estimate risk is 24 hours before a potential fibrillation appears since preventive agents need to be taken right away [5].

A huge amount of resources is used to detect and treat post-operative AF (POAF), as evidenced by the markedly higher burden of managing patients with this arrhythmia and its repercussions.

Gaining higher predictive capacity for POAF may help regulate this arrhythmia and lower the incidence of consequences [6].

Objective

Describing how speckle tracking echocardiography can be used to forecast the likelihood of atrial fibrillation following coronary artery bypass grafting procedure.

Patients and Methods

Ain Shams University hospitals hosted 140 patients with ischemic heart disease (all with chronic coronary syndromes) and sinus rhythm who were prepared for an isolated CABG between December 2017 and November 2018. This was a prospective and observational clinical study.

The hospital's ethical committee and the department council of cardiology at Ain Shams University approved this study, which adhered to the principles outlined in the Helsinki Declaration. All participating patients gave written, informed consent to be recruited into the study after informing them of the goals and procedures of the investigation.

Exclusion criteria

1. Non-sinus rhythm prior to surgery
2. Less than 50% LV systolic function
3. Related valvular procedures
4. Individuals who objected to being part of the research

Patients' evaluation

History: This comprised risk assessment; dyslipidemia, diabetes mellitus, hypertension, and smoking.

Electrocardiography: A 10 mm/mv amplification and a 25 mm/s paper speed were used to record the ECG.

An ECG was performed prior to surgery to ensure sinus rhythm was present. The first week following surgery was utilized to look for any instances of AF using post-operative ECG.

Echocardiography: Using a multi-frequency transducer-equipped GE Vivid 5 machine that has TDI software installed.

For offline analysis, all Doppler and echocardiogram data were saved.

LV volumes and left ventricular ejection fraction

The biplane Simpson's method was used to assess LV volumes; the LV end-diastolic volume (LVEDV), LV end-systolic volume (LVESV).

LV ejection fraction was measured from the apical views (2nd and 4th chamber).

LA volumes

The minimal LA volume (V min), which is measured just prior to the mitral valve closing in end-diastole, and the maximal LA volume (V max), which is assessed immediately prior to the mitral valve opening in end-systole, make up the LA passive volumes [7].

Tissue doppler imaging

Apical four chamber and two-chamber view pictures were captured with a steady ECG recording during breath hold utilizing traditional two-dimensional echocardiography in order to analyze the TDI. To ensure that the myocardial tissue and extracardiac structures could be reliably distinguished, special emphasis was paid to obtaining a sufficient picture. An average of three cardiac cycles in a row were recorded. Adjustment of the frame rate should be between 60 and 80 frames/s or at least 40% of the heart rate.

To get mitral annular velocities, apical views with pulsed wave tissue Doppler imaging (TDI) was recorded. The systolic (S), early diastolic (E'), and late diastolic (A') velocities were measured. In the apical four- and two-chamber views, the mitral annulus was covered by the large volume of the pulsed wave TDI [7].

Left atrial strain (LAS)

For LA speckle tracking analysis, apical 4-chamber view LA focused images were acquired. There was a minimum frame rate requirement of 40 frames per second. A point-and-click method was used to manually trace the endocardial border. In order to determine the peak of the positive strain wave (LASs) during ventricular systole, the LA strain was computed using the reference point placed at the beginning of the P wave of the surface ECG.

LV global longitudinal strain (LVGLS)

The conventional apical four-chamber, two-chamber, and long axis views were used to create the usual two-dimensional grey scale loops of the left ventricle. When moving and saving data digitally for offline analysis, special care was taken to ensure that all patients had frame rates between 50 and 90 frames per second.

The regions of interest were manually selected by determining the endocardial border, the automatic tracking of endocardial contour was carefully validated, and the zone of interest was manually rectified in order to provide optimal monitoring of the entire myocardial wall. Each left ventricular image was divided into six segments for the purpose of performing segmental strain analysis. The peak systolic value of the eighteen segments—which were produced from the three apical images—was then averaged to get the peak systolic longitudinal strain [8].

Patients in this study were allocated into:

Patients of group A: Experienced postoperative AF.

Patients of group B: Continued to have sinus rhythms.

Of the 140 patients in the current study, 95 had sinus rhythm, while 45 had AF.

The mean ± SD of HATCH score of the patients who developed AF (group A) was 1.9 ± 0.84.

HATCH score: Hypertension (1), Age >75 years (1), Transient ischemic attack or stroke (2), Chronic obstructive pulmonary disease (2), Heart failure (2).

Analytical statistics

Information was gathered, coded, edited, and added to IBM SPSS; version 21 of the Statistical Package for Social Science.

Any quantitative data with a parametric distribution were shown as means, standard deviations, and ranges.

When the predicted count in any cell was less than 5%, the Chi-square test and/or Fisher exact test were used for groups comparison with qualitative data.

A parametric distribution and quantitative data were utilized to compare two independent groups using the Independent t-test. One Way Analysis of Variance (ANOVA) was used to compare quantitative data between more than two groups.

The allowable margin of error was set at 5%, while the confidence interval was set at 95%.

Thus, the following p-value was deemed significant:

Non-significant (NS) if P >0.05.

Significant (S) if P <0.05.

Highly significant (HS) at P <0.01.

Results

In this prospective, observational analysis, 140 patients who qualified for coronary artery bypass graft between December 2017 and November 2018 and had sinus rhythm and were included.

There were 140 patients in the study; 43 (31%) were females, and 97 (69%) were males. They were between the ages of 42 and 73, with a mean age of 58.54 ± 6.51 years (Table 1, Figure 1).

Among the patients in the study, 103 had hypertension (73%), 90 had diabetes (64%), 108 had dyslipidemia (77%), and 83 smoked (59%) (Table 1, Figure 2).

We compared both Groups A and B regarding patients’ risk factors and echocardiographic parameters trying to highlight the significant predictors of post-operative AF.

Comparison of the 2 groups

Risk factor: No significant differences were found between both groups regarding patients’ risk factors (age, DM, hypertension, dyslipidemia, smoking) (P-values >0.05).

Echocardiographic parameters:

Conventional echocardiography: The mean LV end diastolic volume (LVEDV) in group A was 78.411 ± 13.554 ml vs 77.344 ± 15.677 ml in group B while the mean left ventricular end systolic volume (LVESV) was 38.233 ± 17.221 ml in group A

Table 1. Patients’ demographics and risk factors.		
Age	Mean SD	58.54 ± 6.51
Gender	Male n (%)	97 (69%)
	Female n (%)	43 (31%)
HTN	n (%)	103 (73%)
DM	n (%)	90 (64%)
Smoking history	n (%)	83 (59%)
Dyslipidemia	n (%)	108(77%)
HTN: Hypertension; DM: Diabetes Mellitus		

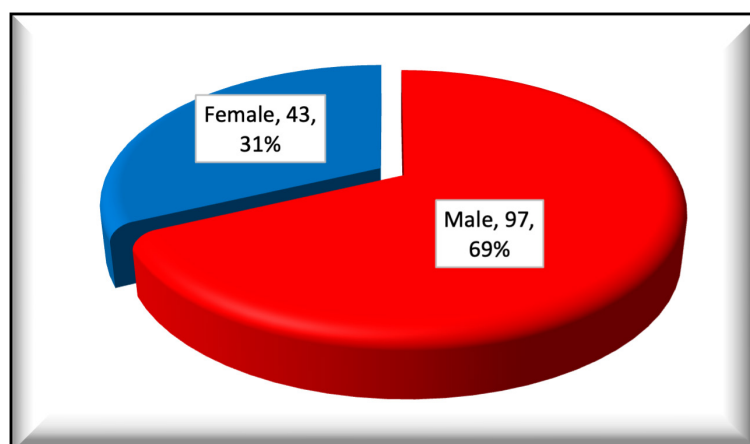


Figure 1. Patients' demographics regarding gender.

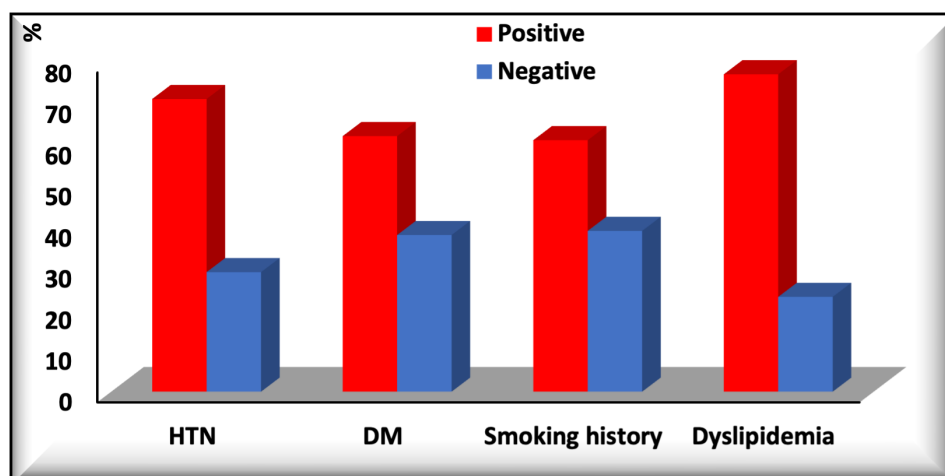


Figure 2. Patients' demographics regarding risk factors.

Table 2. Some parameters and AF development.		
	Number	Number who developed AF
Prolonged bypass time more than 100 ms	60	21
Prolonged cross clamping	63	18
Ungrafted dominant RCA	32	15
Low temperature on bypass	48	24
Early ischemic changes postoperatively	51	30
Hypokalemia post operatively	28	11
Needing vasopressors and noradrenaline	12	7
Preoperative elevated troponin	15	10
P-wave duration more than 100 ms	42	17
Increased P-wave amplitude and duration in lead II preoperatively	54	19

P-wave negative deflection in V1	33	22
Patients with COPD	49	28
Patients on beta blockers preoperatively	83	32
Developing postoperative complications (e.g pericardial effusion, MI, electrolyte disturbance...)	42	35
Preoperative AR	29	18

vs 39.122 ± 16.356 ml in group B. The mean left ventricular ejection fraction (LVEF) was 56.756 ± 6.344% in group A vs 57.255 ± 7.234% in group B.

LV end-systolic volume (LVESV), LV end diastolic volume (LVEDV), and LV ejection fraction (LVEF) did not differ statistically between the two groups (Table 3, Figure 3).

Also, LA volumes were not significantly different between both groups.

Pulsed wave tissue Doppler imaging (TDI): The mean E /E'

ratio was 7.736 ± 2.260 in group A vs 7.992 ± 2.235. This was not significantly different between the 2 groups (Table 4, Figure 4).

Speckle Tracking Echocardiography: The mean LA strain was 21.418 ± 1.617% in group A vs 21.197 ± 1.668% in group B and the mean LV global longitudinal strain was -16.868 ± 3.607% in group A vs -17.285 ± 3.175% in group B.

There was no statistically significant difference between the 2 groups regarding LA strain and LV global longitudinal strain (Table 5, Figures 5 and 6).

Table 3. Comparison between the 2 groups regarding conventional echocardiographic parameters.					
		AF		T-Test	
		Positive	Negative	t	P-value
LVEF	Range	53 - 73	55 - 78	-0.386	0.801
	Mean ± SD	56.756 ± 6.344	57.255 ± 7.234		
EDV	Range	58 - 125	57 - 120	0.319	0.722
	Mean ± SD	78.411 ± 13.554	77.344 ± 15.677		
ESV	Range	24 - 79	26 - 90	-0.058	0.784
	Mean ± SD	38.233 ± 17.221	39.122 ± 16.356		

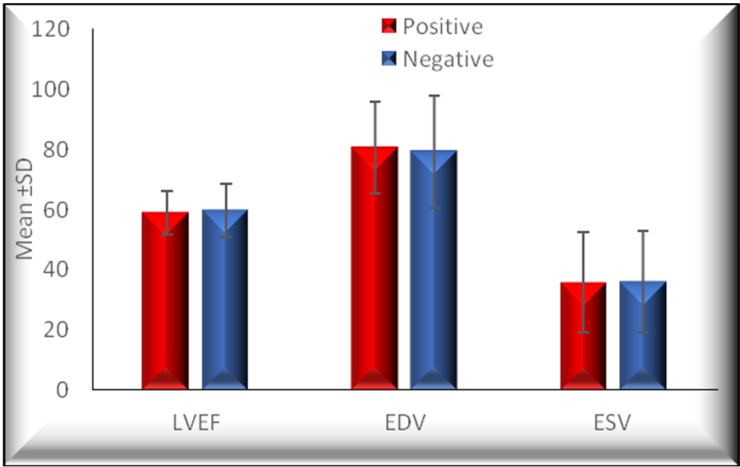


Figure 3. Comparison between the 2 groups regarding conventional echocardiographic parameters.

Table 4. Comparison between the 2 groups regarding (E/E') ratio.				
E/E'	AF		T-Test	
	Positive	Negative	t	P-value
Range	4.1 - 12.8	4 - 12.8	-0.473	0.637
Mean ± SD	7.736 ± 2.260	7.992 ± 2.235		

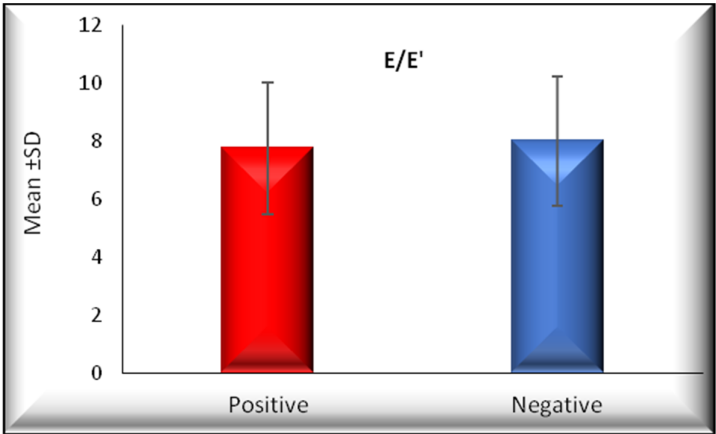


Figure 4. Comparison between the 2 groups regarding (E/E') ratio.

Table 5. Comparison between the 2 groups regarding speckle tracking echocardiography.					
		AF		T-Test	
		Positive	Negative	t	P-value
L A strain	Range	18.8 - 23.8	18.5 - 23.8	0.552	0.582
	Mean ±SD	21.418 ± 1.617	21.197 ± 1.668		
LVGLS	Range	-24.8 - -12.1	-25 - -12.1	0.527	0.599
	Mean ±SD	-16.868 ± 3.607	-17.285 ± 3.175		

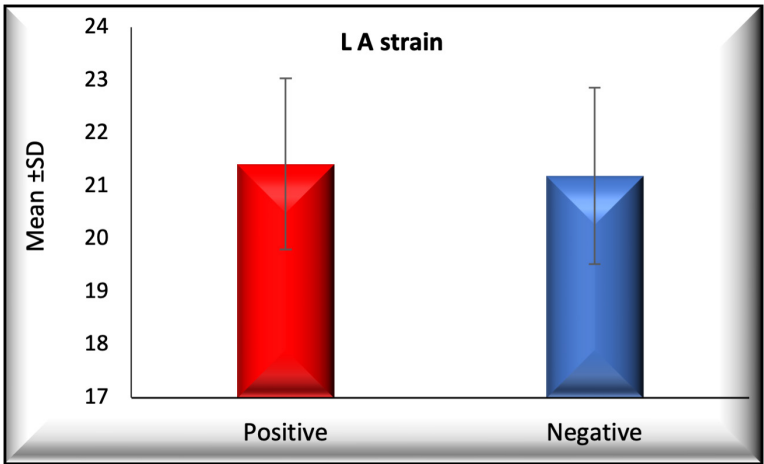


Figure 5. LA strain comparison between the 2 groups.

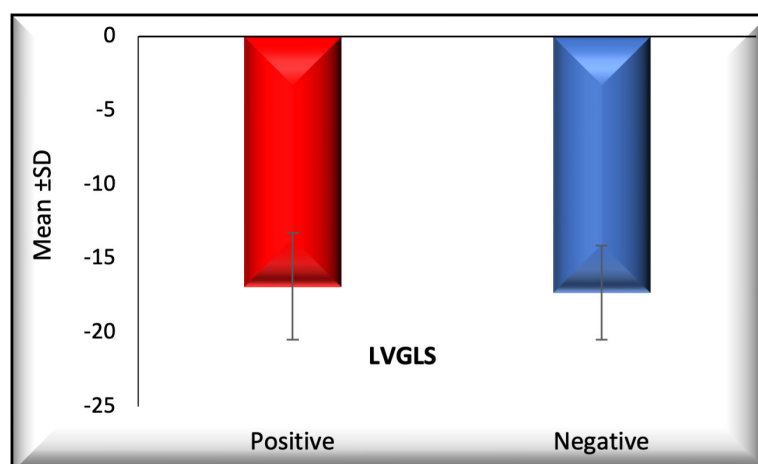


Figure 6. LVGLS comparison between the 2 groups.

Discussion

In order to prevent overuse of anti-arrhythmic medications and their unfavorable side effects, the goal of the current study was to identify the echocardiographic predictors of AF in ischemic patients who were scheduled for coronary artery bypass graft, 140 patients, ages 42 to 73, who were scheduled for isolated coronary artery bypass grafts were included in this study. Baseline parameters, admission information, pre- and post-operative ECG, traditional echocardiographic parameters, TDI, LA strain, and LV global longitudinal strain (GLS) were evaluated. They were divided into two groups: group "A" consisted of 45 patients who experienced POAF, and group "B" consisted of 95 patients who maintained sinus rhythm following surgery.

The patients in group "A" did not exhibit higher left atrial (LA) volumes, and there was no statistically significant difference between the two groups in terms of left ventricular end-systolic volume (LVESV), left ventricular end diastolic volume (LVEDV), or left ventricular ejection fraction (LVEF). Tissue Doppler imaging (TDI) using pulsed wave technology revealed no statistically significant variation in (E/E') between the two groups. Furthermore, there was no discernible difference in systolic LA strain or LV global longitudinal strain (LVGLS) between both groups.

Regarding age, there was no statistically significant difference between the two groups in the current study. This was consistent with findings from a 2014 study by Chenaghlou *et al.* that looked at atrial fibrillation and right atrial dys-synchrony following coronary artery bypass grafting surgery. According to their report, there was no significant difference regarding the age (p value = 0.145) [9].

This, however, contradicted the findings of Tran *et al.*, who found that older age was a significant predictor of POAF. This

could be explained by the inclusion of patients with mitral valve surgery with CABG patients in this analysis [10].

Regarding the risk variables (dyslipidemia, hypertension, smoking, and diabetes), there was no statistically significant difference between the two groups in the current investigation (P value >0.05). This was consistent with the 2007 research by Magee *et al.*, which found no discernible variation in DM between the two groups [11].

Age, diabetes, cholesterol, and smoking were found to be significant predictors of POAF in patients following isolated CABG, according to a 2015 study by Tsai *et al.* The greater sample size in this study (266 patients) compared to 140 in our study, as well as the higher number of patients who had POAF in this study (47%) compared to 32% in our study, may be the cause of the discrepancy between their and our results [12].

Regarding LV end-systolic volume (LVESV), LV end diastolic volume (LVEDV), and LV ejection fraction (LVEF), our investigation showed no significant differences between both groups. This was in line with a 2016 study by Ozben *et al.* that found no appreciable differences in LV volumes and EF between the groups that developed POAF and the ones that continued to stay in sinus rhythm [13].

Our study was inconsistent with the same study's findings, which showed that the AF group had a greater LA diameter and E/e' ratio.

Systolic LA strain and LV global longitudinal strain (LVGLS) were not substantially different between both groups in our investigation. This was also in line with research conducted in 2016 by Ozben *et al.*, which found that there was no statistically significant difference in LA strain and LV global longitudinal strain between the two groups [13].

In a 2013 study by Chua *et al.* evaluating predictors of POAF, there was no statistically significant difference in LVEF, DM, or hypertension between the two groups. This was consistent with what we found [14].

Limitations

One potential limitation of this study is that the study population may have been skewed because it only included patients who had high-quality transthoracic echocardiograms conducted at our institution before surgery.

Secondly, the trial was conducted at a single center and the patient population was quite limited. Furthermore, AF was only regarded as existing when it was objectively documented; it may be temporary, and not all occurrences may be identified. That being said, it is currently not feasible to continuously check for instances of “silent” AF. Hence, it is vital to identify the occurrence and implications of predictable AF. Furthermore, as our observations were restricted to the hospital stay, we were unable to make inferences about the long-term results.

Conclusion

Regarding risk factors and echocardiographic measures (LA volumes, LVEF, LVESV, LVEDV, E/E' ratio, LA strain, and LVGLS), there was no discernible difference between the two groups.

Recommendations

- Larger studies with increased sample size are recommended for proper evaluation of POAF predictors.
- Using advanced echocardiographic modalities (as 3D echocardiography) to predict POAF.
- Long term follow up.
- Using other types of investigations like MRI to predict other causes of POAF.

Authors' Contribution

Bassam S Hennawy: writing, review and editing. Karim Mounir Kamel: data curation, writing-original draft. Ahmed Mohammed Onsy: supervision. Ahmed Mohammed Abd-Elsalam: visualization, investigation.

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Conflict of Interest

The authors have no relevant financial or non-financial interests to disclose.

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