The Correlation between Left Atrial Longitudinal Strain and Atrial Fibrillation in Dilated Cardiomyopathy

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Abstract

Objectives: To assess the correlation between left atrial (LA) longitudinal strain and occurrence of atrial fibrillation (AF) in patients with dilated cardiomyopathy (DCM). Methods: 100 patients with DCM were evaluated. Conventional and speckle tracking echocardiography were done to evaluate LA diameters, volumes and longitudinal strain. Results: Left atrial dimensions and volumes were significantly greater in AF group. LA longitudinal strain and LA emptying fraction were significantly lower in AF group. LA longitudinal strain and LA minimal volume are independent predictors for AF presence. ROC curve showed that LA longitudinal strain cut-off value <11.1% can predict the presence of AF in DCM patients with 96% sensitivity and 95.3% specificity (AUC 0.982, 95% CI 0.959–1.0, P < 0.001) Conclusion: Left atrial longitudinal strain was significantly reduced in AF in the setting of DCM. LA longitudinal strain and LAVmin are independent predictors for AF occurrence in this group of patients with LA strain values <11.1% can be used to predict AF in DCM.

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Keywords: Left atrial longitudinal strain, dilated cardiomyopathy, atrial fibrillation.

Introduction:

Atrial fibrillation (AF) and dilated cardiomyopathy (DCM) are very closely linked. AF is the most common sustained arrhythmia in patients with DCM. Patients with DCM have higher probability to develop AF than those without heart failure **[1]** .

There is a rising concern about understanding left atrial structure and function in patients with DCM and AF; due to their different clinical implications in heart failure as deterioration of LA function during AF diminishes LV stroke volume that may result in developing of HF symptoms. In turn, the result of abnormal

LV function is increased filling pressure, negatively affecting LA volume and function**[2].** Deterioration of LA function in patients with AF and DCM is associated with greater risk for cardiovascular events especially thromboembolic events, hence assessment of LA structure and function is important to predict both risk for these events and the success of preventing them **[3].**

Assessment of left atrial function in patients with DCM and AF with speckle tracking echocardiography (STE) can explain its role in the pathogenesis, diagnosis, prognosis and management of this group of patients **[4].** Thus, we aimed at evaluating the correlation between left atrial strain assessed by speckle tracking echocardiography and the occurrence of AF in patients with DCM.

Patients and methods:

Study design:

This is a single center cross sectional study that included 100 consecutive patients with DCM refered for echocardiographic evaluation at cardiology depatment of Benha University Hospitals, Egypt during the period from January to December 2019. DCM was defined as enlargement and dilation of the left ventricle with impaired systolic function defined as left ventricular ejection fraction (LVEF) less than 40%. They were classified into two groups: group I, 50 patients with DCM and sinus rhythm and group II, 50 patients with DCM and AF. All the patients of group I didn't report any previous episode of AF. ECG was performed for all patients to confirm the rhythm. The study was approved by the local ethics committee at our institution, with informed consent from all patients. Exclusion criteria included organic valvular disease, prosthetic valves, intra-cardiac shunts, implanted medical devices, atrioventricular conduction disturbances, rhythm other than SR or AF.

Echocardiography:

Echocardiography was performed with the commercially available system (Philips EPIQ 7 Ultrasound System, Andover, MA, USA) equipped with 3.5-MHz phased array transducer. LVEF was calculated using the modified biplane Simpson's method **[5]** . LA antero-posterior diameter was measured in the parasternal long axis view. Transverse and longitudinal LA diameters were measured in apical four- chamber view**[6].** LA volumes were measured at end systole (LA maximal volume "LAVmax") and end diastole (LA minimal volume "LAVmin"), in apical four-chamber view. LA emptying fraction (LAEF) was calculated using the following formula, LAEF = (LAVmax – LAVmin)/LAVmax $\times$100%**[7]** . For two-dimensional speckle tracking echocardiography (2DSTE), sector depth and size were optimized to achieve perfect visualization of LA in the apical 4-chamber view with a frame rate between 60 and 100 fps. End-systole was defined by the aortic valve closure in the apical long-axis view. The LA endocardial border was manually traced and the region of interest was adjusted to the thickness of the LA wall **[8]** . Left atrial reservoir strain was measured as the peak positive longitudinal strain during ventricular systole **[9] (Figure 1)** . All measurements were performed by an experienced operator. To determine the interobserver variability, all measurements were repeated by a second operator blinded to the values obtained by the first operator.

Statistical analysis:

Data were analyzed using the statistical package for the Social Sciences (SPSS) version 25 (IBM Corp., Armonk, NY, USA). Data was summarized using mean and standard deviation for quantitative variables. Qualitative data were expressed as frequency and percentage. Comparisons between groups were done using unpaired t test. Multivariant Logistic regression was done to detect the predictors of AF. Receiver operating characteristic (ROC) curve was used to identify optimal cut-off values of LA strain for prediction of AF. Area Under Curve (AUC) was also calculated. Criteria to qualify for AUC were as follows: 0.90 – 1 = excellent, 0.80-0.90 = good, 0.70-0.80 = fair; 0.60-0.70 = poor; and 0.50-0.6 = fail. The optimal cutoff point was established at point of maximum accuracy. $p < 0.05$ was considered significant.

Results:

Patients' demographics and clinical data:

A total of 132 patients with DCM were evaluated. Thirty-two patients were excluded due to the presence of organic valvular disease (n = 16), prosthetic valve (n = 9), and poor image quality (n = 7). The final study population comprised 100 patients who were classified into 2 groups based on the rhythm whether sinus or atrial fibrillation. Demographic variables and risk factors are presented in **(table 1)** . Group II had significantly greater heart rate (88.48±5.13 vs. 78.04±6.21 bpm; P <0.001).

3.2. Echocardiographic parameters:

LA diameters (anteroposterior, longitudinal and transverse) were significantly greater in group II (5.37±0.38 vs. 4.53±0.29 cm; 6.79±0.40 vs. 6.23±0.30 cm and 5.6±0.38 vs. 4.72±0.31 cm, respectively, P < 0.001). Also, LA volumes (maximal and minimal) were significantly greater in group II (128.2±24.53 vs. 97.34±20.45 ml and 84±19.11 vs. 68.52±23.54 ml, respectively, P <0.001). While, LA emptying fraction was significantly lower in group II (27.76±4.54 vs. 36.24 ±3.47 %; P < 0.001).

There was no significant statistical differences between both groups as regarding left ventricular end systolic volume (LVESV), left ventricular end diastolic volume (LVEDV) and left ventricular ejection fraction (LVEF) (130.74±11.28 vs. 129.66±19.01 ml; P =0.730, 158.70±12.43 vs. 166.88±26.46 ml; P =0.051, and 30.90±3.63 vs. 29.94±4.28 %; P =0.229) ; respectively.

Left atrial longitudinal strain was significantly reduced in group II (7.55 ±1.59 vs. 19.83 ±3.26; P <0.001) **(table 2)** .

Inter-observer variabilities were 4.6 ± 2.8% for LA emptying fraction, 3.6 ± 1.1% for LVEF, and 5.6 ± 3.1% for LA longitudinal strain.

Left Atrial diameters, volumes and function indexes showed significant differences between AF and SR group, as anteroposterior, longitudinal, transverse LA diameters, LAVmax and LAVmin were significantly greater in the AF group, whereas LAEF and PALS were significantly lower in AF group.

Multivariate logistic regression analysis showed that LA longitudinal strain (OR 0.322, 95% CI 0.206–0.503, P < 0.001) and LAVmin (OR 0.922, 95% CI 0.855–0.993, P < 0.033) were independent predictors for AF occurrence in DCM patients.

The receiver-operator characteristic (ROC) curve showed that LA longitudinal strain cut-off value <11.1% has the best diagnostic accuracy (sensitivity = 96%; specificity = 95.3%) in predicting presence of atrial fibrillation in DCM patients (AUC 0.982, 95% CI 0.959–1.0, P < .001) **(Figure 2)** .

Discussion :

Development of AF in patients with dilated cardiomyopathy is an independent marker of worse outcome. Previous studies demonstrated that new onset AF in the setting of cardiomyopathy was independently predicted by a more severe left ventricular dysfunction and a more dilated left atrium **[10]** .

Normal ranges for LA deformation and cut-off values to diagnose LA dysfunction with different diseases have been reported, but data are still conflicting **[4]** . Therefore, we aimed at evaluating the correlation between left atrial strain and the occurrence of AF in patients with DCM and to detect a cut-off value that can predict presence of atrial fibrillation in this group of patients.

The present study demonstrated that PALS which represent the dynamic reservoir function of LA was impaired in DCM patients and it is more significantly lower in AF group. Multivariate logistic regression showed that PALS and LAVmin were independent predictors for the presence of AF in patients with DCM. Also, we demonstrated that LA longitudinal strain cut-off value <11.1% has the best diagnostic accuracy (sensitivity = 96%; specificity = 95.3%) in predicting presence of atrial fibrillation in DCM patients (AUC 0.982, 95% CI 0.959–1.0, P < .001). Therefore, we can use left atrial longitudinal as a simple measure to detect DCM patients at risk to develop AF. Similarly, Kurzawski et al. **[11]** demonstrated that LA conduit strain less than 5.43% and contractile less than - 1.97% distinguished sinus rhythm from AF in patients with LVEF <25%.

Motoki et al. **[12]** demonstrated that total LA strain $< 23.2\%$ was an independent risk factor for AF recurrence in 256 patients with preserved LVEF after ablation due to AF.

LA strain and strain rate during ventricular systole is a marker of atrial distensibility and can be used as an index of LA reservoir function **[13]** . Left atrial strain is a strong and independent predictor of AF recurrence after catheter ablation of paroxysmal AF in patients with preserved EF **[14]** . Schotten et al. **[15]** demonstrated that atrial compliance is impaired by AF even before structural remodeling.

One of the other important predictors of new onset AF in HF patients is LA size. Increased LA volume is associated with a greater risk of AF in elderly, hypertrophic cardiomyopathy, and HF **[16]** . This study demonstrated that LA diameters and volumes were significantly greater in patients with AF. Moreover, LA minimal volume was found to be a good predictor of AF presence in patients with DCM. However LA emptying fraction (LAEF) was significantly lower in AF group. Matei et al. **[17]** found that increased LA diameters proved to be good predictive factors for the presence of permanent AF in a group of 348 DCM patients with sinus rhythm who followed for a mean of 60 months. Similarly, Tuomainen et al. **[18]** showed a significant increase in LA anteroposterior diameter in AF patients in the setting of DCM. Cho et al. **[19]** reported that patients who developed new AF had larger LA dimensions and volumes with lower LAEF.

Limitations:

Our study had some limitations. Firstly, the sample size was relatively small. Secondly, the lack of standardization in the left atrial strain measurement together with differences in software between manufactures. Moreover, there is no dedicated software for atrial strain and all calculations were performed by the software initially dedicated for the left ventricle.

Conclusion:

Left atrial longitudinal strain was significantly reduced in AF in the setting of DCM. LA longitudinal strain and LAVmin are independent predictors for AF occurrence in this group of patients with LA strain values $<11.1\%$ can be used to predict AF in DCM.

Author contributions:

Al-Shimaa Mohamed Sabry: Concept/design, Data analysis/ Drafting article.

Hesham Mohamed Abo El-Enin: Critical revision of article.

Taha Motamed Abdelwahab: Data collection and statistics.

Hany Hasan Ebaid: Data interpretation, revision of article.

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