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Correlation Between Left Atrial Electromechanical Delay and Degree of Left Ventricular Diastolic Dysfunction in Patient with Sinus Rhythm and Preserved Systolic Function

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Abstract

Background: *The Atrial electromechanical delay (AEMD) defined as the delay between the onset of electrical activity and the initiation of atrial contraction and measured using Tissue Doppler imaging (TDI) and electrocardiogram (ECG). Diastolic dysfunction of left ventricle (LV) defined as a condition caused by increased resistance to the filling of LV which may cause symptoms of heart failure. Determining the degree of LV diastolic dysfunction is an important step in echocardiographic laboratory and required the assessment of several parameters according to guidelines of American Society of Echocardiography (ASE) and European Association of Cardiovascular Imaging (EACVI) in 2016.*

Aim: *To investigate the relationship between left atrial electromechanical delay, measured using ECG and TDI and the presence, degree of left ventricular diastolic dysfunction in patients with sinus rhythm and preserved systolic function*

Methods: *This paper reports a prospective observational study of 30 patients who underwent two-dimensional (2D) transthoracic echocardiography (TTE) to assess the degree of LV diastolic dysfunction and to measure left atrial electromechanical delay in patient with sinus rhythm and preserved systolic function. AEMD was defined as the time-interval between P-wave on ECG and the beginning of the averaged spectral TDI-derived A' (septal and lateral sides of the mitral annulus)*

Result: *30 participants were included in the study. 6 patients had normal diastolic function (Group 1), 8 patients had diastolic dysfunction grade I (group 2), 11 patients had diastolic dysfunction grade II (group 3) and 5 patients had grade III diastolic dysfunction (group 4). The mean value of AEMD for group 1 was 41 milliseconds where the mean AEMD for group 2, 3 and 4 were 53, 74.8 and 98.6 millisecond respectively.*

Conclusion: *Worsening of LV diastolic dysfunction probably associated with prominent prolongation of atrial electromechanical delay. AEMD may predict degree of diastolic dysfunction.*

Keywords: *left ventricular Diastolic dysfunction, atrial electromechanical delay, Tissue Doppler imaging.*

Background

Assessment of LV diastolic dysfunction in patient presenting with symptoms of dyspnea or heart failure is an important part of echocardiographic study. In 2016 An Update from American Society of Echocardiography (ASE) and European Association of Cardiovascular Imaging (EACVI) recommended Several two-dimensional (2D) and Doppler parameters to grade diastolic dysfunction [1]. Despite the presence of these several parameters in the flow chart grading diastolic dysfunction, still few patients had labeled as unable to determine the grade of their diastolic dysfunction. Introducing a parameter like left atrial electromechanical delay may help to assess LV diastolic dysfunction in patients with sinus rhythm and preserved systolic function.

Methods

Study Design

This study is a prospective, observational study that includes adult patient who was referred to echocardiography laboratory to undergo a transthoracic echocardiographic study for clinical indication within a 2-month period that ended in august 2021. The study was performed at echocardiography laboratory in Ahmadi hospital, a subsidiary of Kuwait Oil Company. The 30 patients enrolled were of various age group and both sexes. Most of the patient used for this study had one or more of the following problems: diabetes mellitus, Hypertension, stable coronary artery disease.

The inclusion criteria were patients above 18 years with normal LV systolic function and a sinus rhythm on electrocardiogram. Exclusion criteria were patients with LV ejection function of less than 50%, chronic atrial fibrillation, severe mitral annulus calcification on Echocardiographic study, patient with pericardial disease, restrictive and constrictive cardiomyopathy.

Protocol

All the patients underwent a full 2-dimensional transthoracic echocardiographic examination using a transducer 5 MHZ Philips iE33 device. No contrast material was used. The echocardiography scan was performed by a well-trained echocardiographer. The echocardiographic images were saved to a hard drive and reviewed in the system by the expert echocardiographer who supervises the echocardiography laboratory. The echocardiographic examination consistent with obtaining standard views of the parasternal long axis as well as apical 4-and 5-chamber views. A full echocardiographic examination including two-dimensional (2D) and spectral Doppler study in addition to Tissue Doppler imaging (TDI) as per current American Society of Echocardiography (ASE) guidelines.

Left AEMD was measured from the beginning of the electrocardiogram P-wave to the initial point of the spectral TDI-derived A' (2) (Figure 1). In this study, left AEMD was obtained for the septal (septal EMD) and lateral (lateral EMD) sides of the mitral annulus. Averaged AEMD was calculated for each patient.

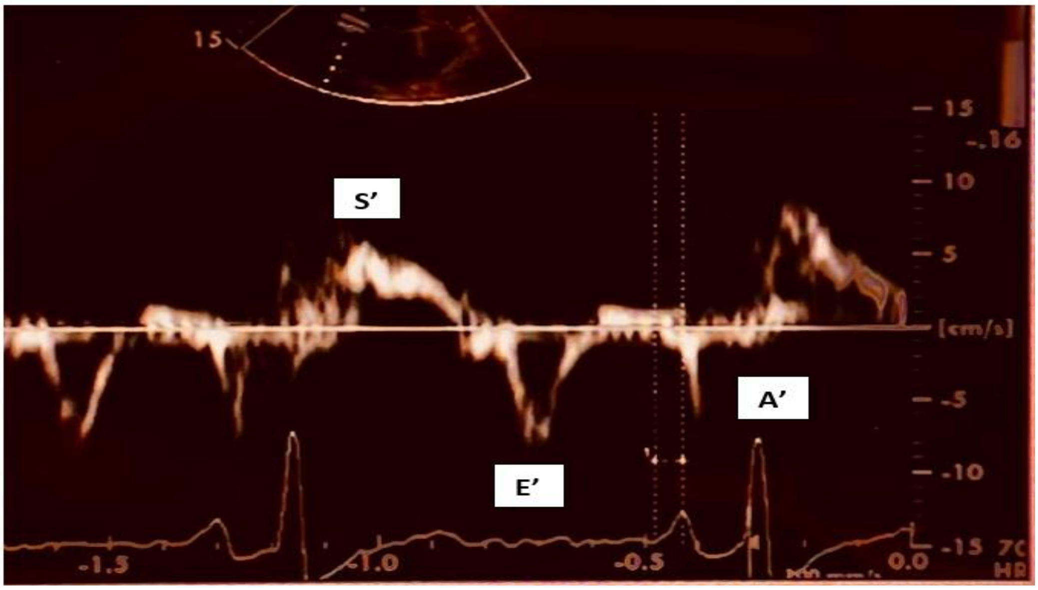

Figure 1: How to measure atrial electromechanical delay: The time interval between P wave on ECG and the onset of the A'. Tissue Doppler imaging tracing done at the septal annulus demonstrating S′ wave (systolic), E′ wave (early diastolic) and A′ wave (late diastolic related to atrial contraction).

To assess LV diastolic dysfunction the following parameters were measured according to 2016 update of ASC and EACVI recommendation:

1-Mitral flow velocities using pulsed Doppler including early rapid filling (E wave) and late filling with atrial contraction (A wave) and their ratio (E/A) from apical 4- chamber view. (Figure 2)

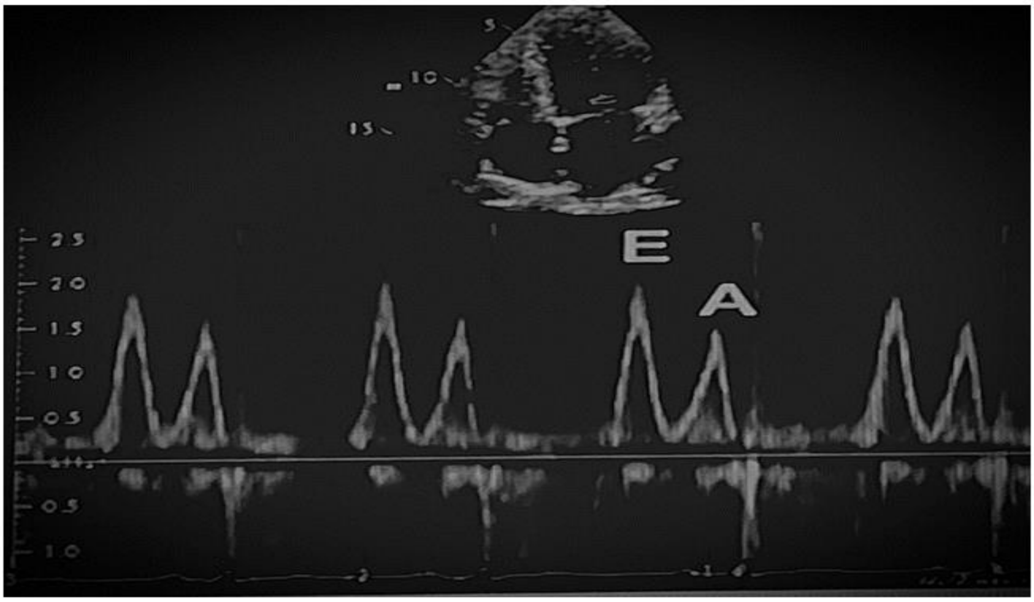

Figure 2: Trans-mitral Doppler flow profile: E wave demonstrates the early filling of LV ventricle and A wave – the late atrial contribution.

2- Mitral annular early (E') and late (A') filling velocities using tissue Doppler imaging from apical 4-chamber view and pulsed Doppler.
3- E/E' ratio
4- Peak velocity of Tricuspid Regurgitation (TR) jet from apical 4- chamber view using color Doppler flow
5- Left atrium volume indexed from apical 2, 4-chamber views.
Patient were categorized according to grade of diastolic dysfunction into 4 group. Group 1 when diastolic function is normal, group 2 –patient with grade I diastolic dysfunction, group 3-patients with grade II diastolic dysfunction and group 4 patients with grade III diastolic dysfunction.

Results

30 participants were included in the study. 14 patients were male and rest of patients were female. Average age was 62 years. 25 patients had diabetes mellitus, 15 patients had stable coronary artery disease and hypertension. 6 patients had normal diastolic function (Group 1), 8 patients had diastolic dysfunction grade I (group 2), 11 patients had diastolic dysfunction grade II (group 3) and 5 patients had grade III diastolic dysfunction (group 4). The mean value of AEMD for group 1 was 41 milliseconds where the mean AEMD for group 2, 3 and 4 were 53, 74.8 and 98.6 millisecond respectively. We found a tendency of more prominent prolongation of AEMD whenever the diastolic dysfunction grade increased (figure 3). Worsening in diastolic dysfunction may associated with prolongation of left AEMD.

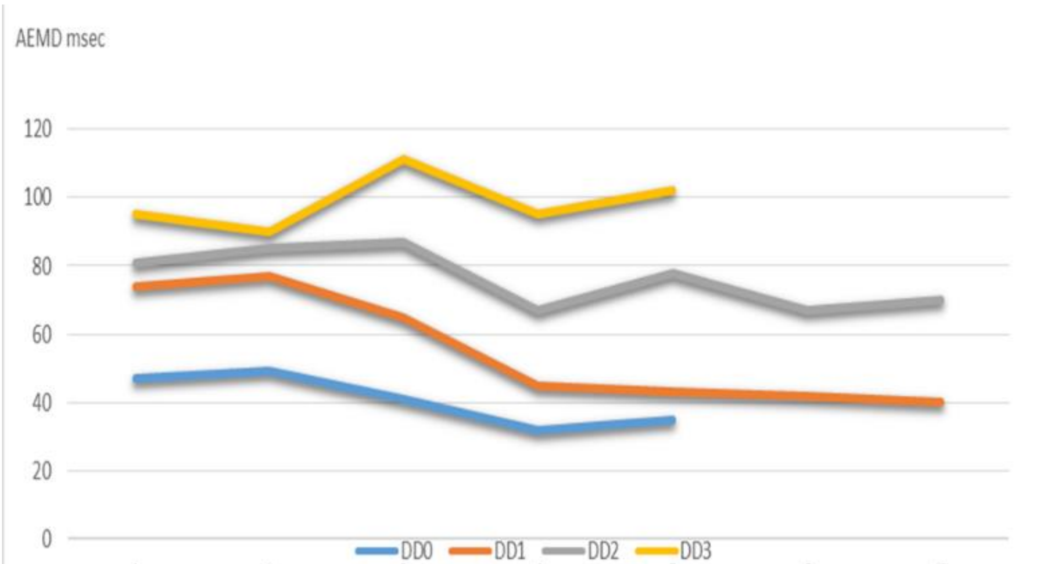

Figure 3: The correlation between grade of diastolic dysfunction and the measurement of atrial electromechanical delay. DD0: diastolic dysfunction grade 0 (normal diastolic function), DD1: diastolic dysfunction grade I, DD2: diastolic dysfunction grade II, DD3: diastolic dysfunction grade III.

Discussion

Atrial electromechanical delay demonstrates an atrial conduction abnormality between the surface electrocardiographic and tissue Doppler echocardiographic measurements. AEMD is measured from the beginning of the electrocardiogram P-wave to the initial point of the spectral TDI-derived A' wave [2]. In general, electromechanical delay has been defined as the temporal interval between the onset of cardiac electrical activity and myocardial contraction [3]. Demir et al reported in one study a significant prolongation of AEMD in patients with Type 2 diabetes mellitus as compared with healthy volunteers [4]. Atrial conduction abnormalities can happen in elderly patients who suffered diseases like hypertension and diabetes mellitus in addition to metabolic syndromes [5]. Majority of these patient had a degree of diastolic dysfunction on echocardiographic examination. It was reported in many studies that prolongation of left AEMD was a predictor of new onset Atrial Fibrillation (AF) and recurrence of AF [6]. The exact mechanism of prolongation of left AEMD in patients suffering Diabetes mellitus type 2 and hypertension is not well known, but it is thought that structural and electrophysiological changes in the atrial myocardium caused by might play a role. Diastolic dysfunction reported up to 75% in diabetic and hypertensive patient [7]. In one study the duration of left atrial EMD was prolonged in patients with preeclampsia which characterized by new-onset hypertension and proteinuria [8].

The structural and electrical changes happened in left atrium in patient with diastolic dysfunction due to variable condition might explain the prolongation of left atrial electromechanical delay [8] and based on this assumption our hypothesis suggests that with worsening of diastolic dysfunction we may observe more prolongation of left atrial EMD. In another words the measurement of left AEMD may be helpful in determining the presence of diastolic dysfunction and possible the grade when other parameters undetermined. To our knowledge, there is no study that assessed left atrial conduction abnormalities using both TDI and ECG in patients with diastolic dysfunction. In our study the prolongation of left atrial EMD were more prominent in patient with advanced diastolic dysfunction.

Conclusion

Worsening of LV diastolic dysfunction probably associated with prominent prolongation of left atrial electromechanical delay. AEMD may predict degree of diastolic dysfunction.

Limitation

The small number of patients recruited is one of the major limitations but the study can be considered as pilot one.

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