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Atrial Electromechanical Delay in Healthy Individuals in Fasting and Postprandial States

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Abstract

Background: Atrial Electro-Mechanical Delay (AEMD) has been defined as the delay between the electrical stimulation and mechanic contractility that may be attributed to several abnormalities in the atria. It is associated with atrial remodeling that finally leads to atrial fibrillation (AF). **Methods:** Fifty five subjects were enrolled in this descriptive observational cross sectional study, (mean age was 33.27 ± 7.49 years, 33 males). All patients were evaluated by precise history taking, clinical examination, twelve lead surface electrocardiography (ECG). ECG gated Echocardiography with measurement of atrial electromechanical coupling (PA), left atrial intra-AEMD over a period of 1 year from July 2017 to July 2018 in Mansoura specialized medical hospital. **Results:** It was found that PA lateral (50.98 ± 8.07 vs. 50.38 ± 7.47 msec, p 0.026), PA Septal (34.87 ± 6.33 vs. 34.16 ± 6.32 msec, p 0.003) and, left intra-AEMD (PA lateral–PA Septal) (16.72 ± 7.34 vs. 16.21 ± 6.57 msec, p 0.01), values were higher in post prandial condition than in fasting state. **Conclusion:** Determining electromechanical intervals as the atrial conduction interval with transthoracic echocardiography is a simple, easy bedside method to be evaluated. PA lateral, PA septal and left atrium EMD are prolonged in postprandial condition than during fasting and it may be predictor of occurrence of postprandial palpitation and hidden atrial fibrillation.

Keywords

Electromechaincal Delay, Left Atrial Remodeling

1. Introduction

Atrial electromechanical coupling delays are the time intervals between the electrical depolarization of the atria and start of atrial mechanical activity. Increased AEMDs can be used as indicators to differentiate patients with recent onset atrial fibrillation from controls without recent onset AF or to expect the occurrence of recent attack of AF as in studies [1]. Prolonged Atrial electromechanical delay reflects the electrical remodeling of the left atrium, which is important for maintenance of AF [2].

Studies display that postprandial glucose stage (PPG) may be taken into consideration as marker for underlying cardiovascular disease (CVD) [3]. Postprandial hyperglycemia (PPH) with fluctuations in glucose level after ingestion may additionally predict destiny CVD mortality and morbidity better in comparison with excessive serum glucose in fasting situation in diabetics persons [4].

Oxidation state is an essential implicating element for vascular endothelial abnormality in PPH. This is ascribed to its complex function in reducing nitric oxide bioavailability and via activating inflammatory responses that worsen the value of oxidation state. That PPH raises CVD risk, even in healthy persons, which recommends a serious need to explain the mechanisms much more better [5].

Oxidation state shares drastically in vascular dysfunction via lowering Nitric Oxide bioavailability through numerous complex mechanisms. Oxidation state effect is raised by presence of continual hyperglycemic state. Recently, it was found that even temporary postprandial peaks of glucose increase occurrence of oxidation [6].

Significant EMDs were found in patients with type 2 diabetes mellitus (T2DM) as compared with healthy persons. Oxidative stress and inflammation have been involved in the development of both AF and DM [7].

Atrial conductivity abnormalities were evaluated by simple non-invasive strategies with the use of electrocardiography and tissue Doppler imaging (TDI) as in previous studies [8] [9].

AEMD has additionally been proven to be longer in many situations that affect heart tissue [10] [11] [12] [13] [14].

The aim of this study was to assess the effect of fasting and postprandial condition on intra-atrial electromechanical coupling in healthy non-diabetic subjects.

2. Methods

2.1. Study Population

Fifty five middle aged healthy subjects were involved in this descriptive cross sectional study, (mean age was 33.27 ± 7.49 years, 33 males). The whole patients were assessed by way of thorough records taking, medical examination, twelve lead surface (ECG), ECG gated echocardiography with assessment of atrial electromechanical coupling (PA), left atrial intra-AEMD over a period of 1 year from July 2017 to July 2018 in department of cardiovascular medicine, Faculty of Medicine, Mansoura University.

2.2. Ethics Statement

All methods have been executed as recommended by the ethical committee of the Faculty of Medicine, Mansoura University. Data were analyzed anonymously. The proposal was defined to all patients; then the whole studied cases gave oral informed consent.

2.3. Methodology

All subjects were assessed by thorough history taking including; age and gender, special habits and past medical history.

Clinical examination included: BP, pulse, general examination and local cardiac examination.

Investigations included: 12 lead surface electrocardiogram, Echocardiography, liver function tests, kidney function tests, fasting and 2 hour post-prandial blood glucose levels.

❖ **Echocardiography**

Conventional echocardiography for assessment of cardiac chamber, left ventricular thickening and ejection fraction according to American Society of Echocardiography (ASE) recommendation for exclusion of cardiac anomaly.

Assessment of Atrial electromechanical coupling:

ECG gated Tissue Doppler echocardiography was performed Using General electric System Vivid-E9 machine with tissue Doppler imaging capability using (2.5 - 5) MHZ probe.

In apical four-chamber view, the pulsed Doppler sample volume was allocated at the level of lateral mitral annulus, and ultimately at septal mitral annulus. The time interval from the onset of the P wave on surface ECG to the start of the late diastolic wave on TDI, which is nominated as PA, was recorded from the lateral mitral annulus (lateral PA), septal mitral annulus (septal PA), the subtract between lateral PA and septal PA (lateral PA-septal PA) was described as intra-left atrial EMD. All measurements were recorded over an average of three cardiac cycles [15]. These measurements were calculated in fasting and 2 hours post prandial.

2.4. Exclusion Criteria

Exclusion Criteria include History of chronic medical disease including: Diabetes mellitus and hypertension, history of structural cardiac disease including valvular heart disease, arrhythmia, left ventricular systolic or diastolic dysfunction and ischemic heart disease, history of chronic renal failure, history of chronic liver disease, persons with abnormal ECG changes as conduction abnormalities and arrhythmia, obese persons with body mass index (BMI) more than 30 kg/m2 and Persons with bad echocardiographic window.

2.5. Statistical Analysis

Data were analyzed via SPSS version 21. The data normality was first tested with a one-sample Kolmogorov-Smirnov test.

Qualitative data were described using number and percentage. The affiliation among specific variables become tested the use of the Chi-square test. Continuous variables were nominated as mean ± SD (standard deviation) for parametric data and median for non-parametric data. The two groups were compared via the Student's t test (parametric data) and the Mann-Whitney test (non-parametric data). The Spearman correlation was used to correlate non-parametric data.

In all of the above statistical tests, the importance threshold was constant at 5% level (p-value). The effects were taken into consideration non-considerable while the possibility of error was greater than 5% ($p > 0.05$); considerable while the probability of errors was less than 5% ($p < 0.05$); and highly sizeable when the probability of error was much less than 0.1% ($p < 0.001$). The smaller the p-value obtained, the extra-large the results.

3. Results

The mean age among all subjects was a 33.27 ± 7.49 year, with their age ranging from 21 to 47 years. The ratio of subjects with age <30 y was 38.2%, subjects with age 30 - 40 y was 36.4%, subjects with age > 40 y was 25.4% there was 33 male and 22 female with male/female ratio (60%) versus (40%) (Table 1).

Among the study population, there were 9 smokers and 46 non-smokers with smoker/non-smoker ratio (16.4%) versus (83.6%) (Table 1).

As shown in Table 2 the PA lateral is significantly prolonged in post prandial state than in fasting.

As shown in Table 3 the PA septum is significantly prolonged in post prandial state than in fasting.

As shown in Table 4 the left atrial EMD is significantly prolonged in post prandial state than in fasting.

As shown in Table 5 smoking prolong left atrium EMD, in smoker subjects the fasting EMD was 28.55 ± 2.87, post prandial EMD was 30.88 ± 3.10, while in

Table 1. Demographic data of the studied group.

Variables	Study group (n = 55)	
	No	%
Gender		
Male	33	60.0%
Female	22	40.0%
Age/years		
<30 y	21	38.2%
30 - 40 y	20	36.4%
>40 y	14	25.4%
Mean ± SD	33.27 ± 7.49	
Min - Max	21.00 - 47.00	
Smoking		
yes	9	16.4%
No	46	83.6%

SD: Standard Deviation.

Table 2. relation between fasting, post prandial PA lateral.

PA lateral (ms)	Fasting PA lateral	Postprandial PA lateral	Paired t-test	p-value
Mean ± SD	50.38 ± 7.47	50.98 ± 8.07	2.29	0.026*
Min - Max	39.00 - 63.00	39.00 - 65.00		

*Highly significant p < 0.001, P value: probability value, t test: student t test, msec: millisecond.

Table 3. Comparison between fasting and post prandial PA septum.

PA septum (ms)	Fasting PA septum	Post prandial PA septum	Paired t-test	p-value
Mean ± SD	34.16 ± 6.32	34.87 ± 6.33	3.16	0.003*
Min - Max	22.00 - 50.00	22.00 - 50.00		

*Highly significant p < 0.001, P value: probability value, t test: student t test, msec: millisecond, SD: standard deviation.

Table 4. Comparison between fasting and post prandial Left intra-atrial EMD.

Left intra-atrial EMD (ms)	Fasting Left intra-atrial EMD	Post prandial Left intra-atrial EMD	Paired t-test	p-value
Mean ± SD	16.21 ± 6.57	16.72 ± 7.34	2.67	0.01*
Min - Max	9.00 - 31.00	9.00 - 35.00		

*Highly significant p < 0.001, P value: probability value, t test: student t test, msec: millisecond, EMD: electromechanical delay.

Table 5. Relation between fasting, post prandial Left intra-atrial EMD and smoking.

EMD (ms)	Smoking		t-test	p-value
	Yes (n = 9)	No (n = 46)		
Fasting Left intra-atrial EMD	28.55 ± 2.87	13.80 ± 3.73	11.18	<0.001**
Post prandial Left intra-atrial EMD	30.88 ± 3.10	13.95 ± 3.89	12.27	<0.001**

**Highly significant p < 0.001, P value: probability value, t test: student t test, msec: millisecond, EMD: electromechanical delay.

non-smoker subjects the fasting EMD was 13.80 ± 3.73, post prandial EMD was 13.95 ± 3.89.

As shown in Table 6 the left atrium EMD is more prolonged in males than in females, in male subjects the fasting EMD was 17.72 ± 7.38, post prandial EMD was 18.45 ± 8.38, while in female subjects the fasting EMD was 13.95 ± 4.34, post prandial EMD was 14.13 ± 4.46.

As shown in Table 7 direct correlation between left atrium EMD and increasing age, in subjects > 30 years old the fasting EMD was 13.00 ± 3.97, post prandial EMD was 13.00 ± 4.32, while in subjects 30 - 40 years old the fasting EMD was 15.15 ± 5.20, post prandial EMD was 15.50 ± 5.39, in subjects < 40 years old the fasting EMD was 22.57 ± 7.31, post prandial EMD was 24.07 ± 8.38.

Table 6. Relation between fasting, post prandial Left intra-atrial EMD and sex.

EMD (ms)	Sex		t-test	p-value
	Male (n = 33)	Female (n = 22)		
Fasting Left intra-atrial EMD	17.72 ± 7.38	13.95 ± 4.34	2.155	0.036*
Post prandial Left intra-atrial EMD	18.45 ± 8.38	14.13 ± 4.46	2.210	0.031*

*Highly significant p < 0.001, P value: probability value, t test: student t test, msec: millisecond, EMD: electromechanical delay.

Table 7. Relation between fasting, post prandial Left intra-atrial EMD and age.

EMD	Age/y			ANOVA test	p-value
	<30 y (n = 21)	30 - 40 y (n = 20)	>40 y (n = 14)		
Fasting Left intra-atrial EMD	13.00 ± 3.97[a]	15.15 ± 5.20[b]	22.57 ± 7.31[ab]	13.72	<0.001**
Post prandial Left intra-atrial EMD	13.00 ± 4.32[a]	15.50 ± 5.39[b]	24.07 ± 8.38[ab]	15.21	<0.001**

ab: similar letters indicate significant difference between groups by post hoc LSD test. **Highly significant p < 0.001, P value: probability value, Y: years, EMD: electromechanical delay.

4. Discussion

Electro-Mechanical Delay (EMD) has been defined as the delay between the onset of cardiac electrical activity and myocardial contraction that results from structural changes in the atria [8].

Disorders of atrial conductivity are often seen in old people and/or in patients with structural cardiac diseases, for example mitral valve MV diseases, dilated cardiomyopathy DCM, decreased coronary flow, and hypertension [16] [17] [18] [19].

AEMD is recognized to be a marker of recent onset atrial fibrillation [20].

Chao *et al.*, 2011 have proved that AEMD is related to atrial remodeling which eventually result in atrial fibrillation, so assessment of atrial electromechanical delay could be used to decide who is susceptible to develop atrial fibrillation [2]. In clinical practice, AF is one of the most typical persistent cardiac dysrhythmias, and its miles related to increased threat for ischemic cerebral stroke, heart failure HF, and whole mortality [7].

To our best knowledge, there are no studies before had evaluated atrial conduction abnormalities using both tissue Doppler imaging (TDI) and electrocardiography (ECG)to assess effect of fasting and post prandial condition on left atrium electromechanical delay in healthy non diabetic subjects. In this descriptive cross sectional study we aimed to determine the relation between atrial conduction abnormalities via the resting electrocardiographic and tissue Doppler measurements in healthy non diabetic subjects in both fasting, postprandial conditions.

In this study, the PA septum, PA lateral, left atrium EMD were prolonged in postprandial state compared with the fasting state, also the postprandial EMD is directly proportional to the level of post prandial blood glucose level.

Ayhan *et al.*, 2012 found that left AEMD was considerably higher in individuals with intolerance of glucose metabolism than in controls [21].

In accordance with previous studies (Rachid *et al.*, 2017) which found that with growing age, the LA conduction turns into be slower and the LA compliance reduces, suggesting the presence of age related fibrotic abnormalities of the LA wall [22], also (Rosca *et al.*, 2011) showed that Age is a known cause of atrio-ventricular conduction delay as well as the increased incidence of atrial fibrillation [23]. We found also direct correlation between left atrium EMD and increasing age.

We also found that left atrium EMD is more prolonged in males than in females, in male subjects the fasting EMD was 17.72 ± 7.38, post prandial EMD was 18.45 ± 8.38, while in female subjects the fasting EMD was 13.95 ± 4.34, post prandial EMD was 14.13 ± 4.46 and this may explains why male sex is a risk factor of atrial fibrillation as showed by (Benjamin *et al.*, 1994) [24].

The study also showed that smoking prolong left atrium EMD, in smoker subjects the fasting EMD was 28.55 ± 2.87, post prandial EMD was 30.88 ± 3.10, while in non-smoker subjects the fasting EMD was 13.80 ± 3.73, post prandial EMD was 13.95 ± 3.89, this goes with a study containing fifty smokers and forty non-smokers, it was documented that inter- and intra-atrial EMD was considerably higher in cigarette smokers if they were compared with non-smokers, and also the amount of cigarette smoking has a strong link with inter-atrial EMD [25].

Limitations of the study:

There were numerous limitations to our thesis. First, being a cross-sectional study is the main hassle of our study. Subjects were not observed prospectively for atrial arrhythmic episodes. Second, our study became conducted in a single center with a surprisingly small range of participants. Third, all individuals were in normal sinus rhythm during the whole study, we did not perform holter examination to analyze presence of atrial arrhythmias in our studied persons. Fourth, conduction times were obtained with tissue Doppler echocardiography, and the gold preferred technique, electrophysiological study, was not performed.

5. Conclusions

In conclusion, we found that left atrium EMD is prolonged during postprandial condition than during fasting. Left atrium EMD is prolonged in smokers than in non-smokers. Left atrium EMD is prolonged in males more than in females. Left atrium EMD is prolonged in older age than in younger.

Determining electromechanical occasions along with the atrial conduction interval with echocardiography is a non-invasive and simple method to measure. Large-scale and long-term follow-up prospective studies are required to set up the predictive value of atrial conduction parameters for the future development of AF in subjects in whom AEMD is discovered to be prolonged.

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Conflicts of Interest

The authors declare that they have no conflict of interest.

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