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Usefulness of Electrocardiographic QT Interval to Predict Left Ventricular Diastolic Dysfunction

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ABSTRACT:
Over time, heart failure with normal systolic function constituted a real health problem of worldwide morbidity and mortality. Despite the paucity of research focused on, Echocardiography with Doppler imaging is an easy and accurate method for the diagnosis of this syndrome. In this study, we select 75 patients complaining of symptoms of dyspnea and lower limbs swelling, unexplained by obvious cause. Then, we linked the ultrasound findings with the electrical parameters and processed it at statistical method. After that, we enrolled 100 patients at the radiology department, respectively and randomly, and then we concluded in the same order after deeply processing it with statistic programs. There was a significant statistical correlation between the corrected QT interval and the presence of left ventricular diastolic dysfunction. Therefore, it can be considered that the corrected QT interval is an independent predictor of the left ventricle diastolic function.

Keywords*: Diastolic Dysfunction, E vel, E' vel, HF-nEF, QTc interval.*

1. INTRODUCTION

In the last two decades, it was not well described that there is heart failure with a normal ejection fraction (HF-nEF), but many studies have demonstrated the occurrence of heart failure with a good systolic function. Nowadays, there is an explicit increase in the prevalence of this syndrome. It might be due to the difficulty of diagnosing it in the past [1]. Many medical institutions identified the proportion of heart failure with a preserved ejection fraction with 50-55% of all cases of heart failure [1,2,3]. However, prevalence increases dramatically with age and it is most common in women of all age groups in comparison with men [4].

The hospitalization rates were similar among patients with normal and low systolic function [5,6]. Another factor that gives the HF-nEF its importance is mortality, which is approximately parallel to those induced by HF with dropped systolic function [1,2,5]. Diastolic dysfunction was considered as a cornerstone in the pathogenesis of HF-nEF. Few studies are available in our hands about expectation of a relaxation defect through purely electrical variables. We will try through this research to find a relationship linking the corrected QT interval in electrocardiography with the presence of diastolic dysfunction and anticipate the possibility of their existence.

2. METHOD

2.1 Materials

We used (PHILIPS M2424A SONOS 5500 Ultrasound Machine/USA) as a certified echocardiography device in this study. We did ECG for each patient using (FUKUDA DENSHI – AUTOCARDINER FCP-2155/Japan), then we got the reported electrical parameters measured automatically by the machine, attached to the end of the chart sheet. For data processing, we used the statistic program; SPSS (IBM® SPSS® Statistics 18). Then, we used the independent samples T test to deal our data, considering the P-value < 0.05 as an important value for statistical relations.

2.2 Exceptions

An exception included patients with atrial fibrillation and those who were discharged in the last two weeks from the coronary care unit, regardless of the indication of hospitalization.

2.3 Sample Collection

2.3. 1 First Phase

This phase included 75 patients forming the first group, which represents the symptomatic sample "the target group". This group involved patients who referred to the echocardiography imaging unit in order to investigate unexplained dyspnea or swelling of the lower limbs.

Selection of patient was done in a retrospective manner during the period between September/2014 and up to February/2015. We correlate age, sex, morbidity, in addition to the used drugs (excluding the drugs added a month before) as statistical variables.

2.3. 2 Second Phase

This phase included 100 patients forming the second group, which represents the asymptomatic sample "the witness group".

Patients in this group were chosen in a prospective manner from those who were referred to echocardiography imaging unit regardless the indication of imaging. Enrollment was randomized and sequential during the period from March/2015 to August/2015.

2.4 Inclusion Criteria

Measuring the Corrected QT Interval was considered on the longest QT interval at any lead using Bazett's Formula equation [7]. The normal ECG was defined as follows: heart rate between 50-100 bpm, normal axis, Sinus rhythm, PR period ranging from 120 to 200 msec, QRS complex width less than 120 msec, in addition to length of the QTc less than 450 msec and without morphological changes in waves and conduction.

We adopted the following standard criterion to diagnose left atrial enlargement; PR length greater than 120 msec with negative part of 0.04 seconds or depression the negative part is greater than 0.1 mvol on the precordial lead V1 [8]. In addition, we considered Sokolow-Lyon criteria to diagnose left ventricle hypertrophy [9].

We classified diastolic dysfunction as listed in ACC/AHA guidelines [10]; Normal E' > 8 cm/s, DDG-I E' < 8 cm/s & E/A < 0.8, DDG-II E' < 8 cm/s & E/A = 0.8 – 1.5, DDG-III E' < 8 cm/s & E/A > 1.5 or DT < 150 ms.

3. RESULTS

3.1 Statistically Result Correlation

3.1.1 First Group

Average age was about 57 years old, male and female were approximately equal. More than half of the patients of this group suffered from arterial hypertension. About a third of them complained of diabetes mellitus –by its two types- while less than the half had a coronary artery disease. High serum cholesterol levels were also found in quarter of the patients.

Based on these data; beta-blockers, renin-angiotensin system inhibitors and statin class were used by half of patients, while the percentage of using calcium channel blockers was not important. In addition to that, a quarter of patients were given diuretics.

Pulse rate was about 77 bpm while the overall result of recording electrical periods (QRS-PR) was close to normal. We got some kind of lengthening in the QT interval and its corrected type. A quarter of these patients had a defect in the left atrium, while one-third had left ventricle hypertrophy. The Main types of blocks (LBBB,RBBB) did not constitute a major disorder. A completely normal ECG was found in a significant proportion of patients.

The medium ejection fraction was about 50% and left atrium diameter average reached 3.8 cm, while the other echoic variables registered in our research were approximately normal. A third of the patients of this group were enjoying a good diastolic function while the first and second grades are distributed about two-thirds of patients, leaving the third grade of the model with a little spread “Table 1”.

3.1.2 Second Group

The average age was 57 years old, similar to the first group, although it was slightly higher in females when compared to males. The percentage of hypertension was almost the half. Diabetes mellitus was found in about quarter of patients. Third of patients complained of coronary artery disease. Moreover, High cholesterol patients were found in about one-fifth. Based on the above, more than half of these patients had used beta-blockers, while the use of statins was accounted for a little less than that. Renin-angiotensin system inhibitors were a necessary medication for about one-third of the patients, while less than one-fifth of patients had used calcium channel blockers and diuretics.

Heart rate was about 74 bpm thus, achieving value relatively close to the first group, while the electrical recordings (QRS-PR) were approximately normal. Prolonged (QT) interval and its corrected form were not strongly noticeable as the first group. However, the percentage of left atrium defects was less than one-fifth. About a quarter of patients had left ventricle hypertrophy. Intraventicular conduction defect, mainly (LBBB-RBBB), did not constitute an important proportion, while the presence of quite normal ECG was found in a quarter of patients.

The average value of ejection fraction was about 52%, while the median diameter of the left atrium was similar to that in the first group. All remaining echoic parameters adopted in our research fell within nature values or relatively around it. We noticed that two-fifths of patients had a good diastolic function, a quarter of

patients suffering from first and second grades of diastolic dysfunction, while grade three diastolic dysfunction was found in about ten percent of patients "Table 2".

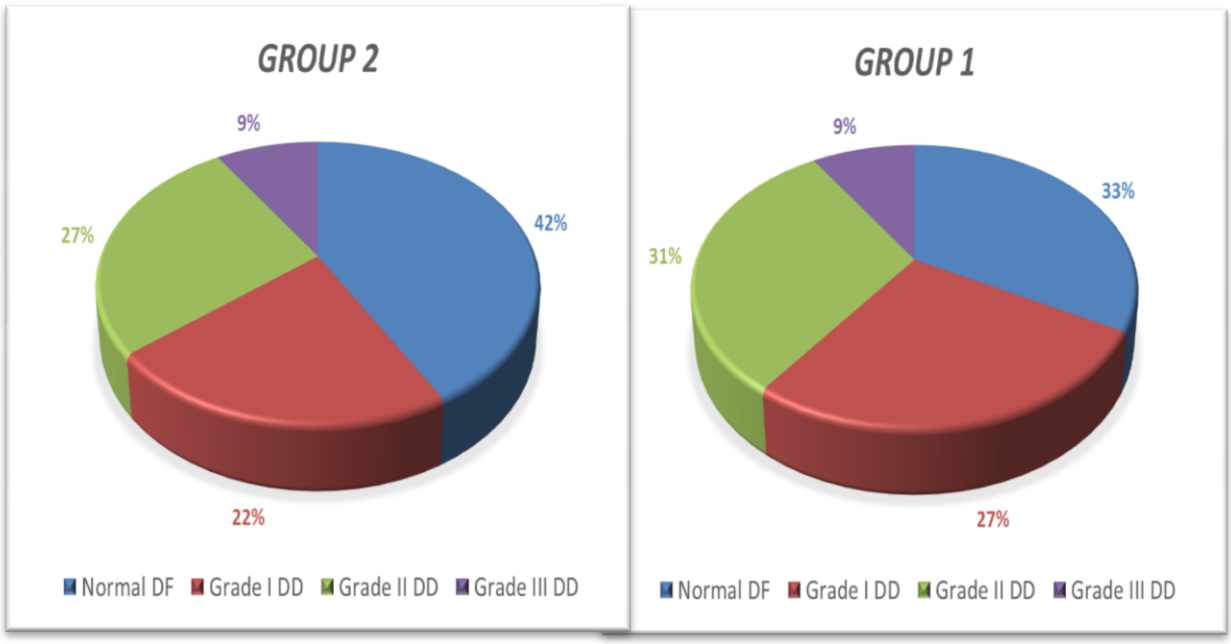

Figure 1, diastolic dysfunction distribution in the two groups.

Table 1 - *Group one characters n=75*

Variable		Total	Septal E' >8 cm/s (n=25)	Septal E' <8 cm/s (n=50)	P-Value
Age (year)		57 ± 8	51 ± 6	60 ± 6	< 0.000
Gender (n)	Male	39 (52%)	13 (52%)	26 (52%)	0.5
	Female	36 (48%)	12 (48%)	24 (48%)	0.5
HTN (n)		45 (60%)	11 (44%)	34 (68%)	0.04
DM (n)		22 (30%)	3 (12%)	19 (38%)	0.01
CAD (n)		34 (45%)	6 (24%)	28 (56%)	0.007
Hyperlipidemia (n)		19 (25%)	9 (36%)	10 (20%)	0.1
Medication (n)	ACEIs & ARBs	33 (44%)	5 (20%)	28 (56%)	0.002
	β Blockers	32 (42%)	6 (24%)	26 (52%)	0.01
	CCBs	9 (12%)	3 (12%)	6 (12%)	0.6
	Diuretics	17 (22%)	7 (28%)	10 (20%)	0.3
	Statins	41 (54%)	14 (56%)	27 (54%)	0.5

HR (bpm)	77 ± 15	66 ± 7	82 ± 10	<0.000
PR Interval (ms)	167 ± 16	156 ± 18	172 ± 18	0.001
QRS Duration (ms)	116 ± 8	110 ± 19	119 ± 13	0.02
QT Interval (ms)	459 ± 56	422 ± 15	478 ± 16	<0.000
QTc Interval (ms)	477 ± 51	442 ± 15	494 ± 14	<0.000
LAA (n)	19 (25%)	2 (8%)	17 (34%)	0.01
LVH (n)	29 (39%)	5 (20%)	24 (48%)	0.01
LBBB (n)	6 (8%)	2 (8%)	4 (8%)	0.6
RBBB (n)	9 (12%)	4 (16%)	5 (10%)	0.3
Normal ECG findings (n)	9 (12%)	8 (32%)	1 (2%)	<0.000
EF (%)	50 ± 11	57 ± 7	46 ± 8	<0.000
LAD (cm)	3.8 ± 0.9	3.2 ± 0.5	4.1 ± 0.6	<0.000
E vel (cm/sec)	87 ± 3	85 ± 5	88 ± 6	0.05
A vel (cm/sec)	72 ± 10	65 ± 5	75 ± 7	<0.000
EDT (ms)	236 ± 37	211 ± 12	248 ± 13	<0.000
E/A Ratio	1.2 ± 0.1	1.3 ± 0.1	1.1 ± 0.1	0.001
S.E' (cm/sec)	7.5 ± 3.2	9.7 ± 1	6.5 ± 0.5	<0.000
L.E' (cm/sec)	7.4 ± 3	9.5 ± 1.8	6.4 ± 0.6	<0.000
S E/E' Ratio	12 ± 4.8	8.8 ± 1	13.6 ± 1.5	<0.000
L E/E' Ratio	12.7 ± 3.2	10.5 ± 1.2	13.7 ± 1.7	0.01

Table 2 - *Group two characters n=100*

Variable		Total	Septal E' >8 cm/s (n=42)	Septal E' <8 cm/s (n=58)	P-Value
Age (year)		57 ± 16	44 ± 5	61 ± 7	< 0.000
Gender (n)	Male	43 (43%)	17 (40%)	26 (45%)	0.4
	Female	57 (57%)	25 (60%)	32 (55%)	0.4
HTN (n)		48 (48%)	15 (35%)	33 (57%)	0.02
DM (n)		23 (23%)	5 (12%)	18 (31%)	0.02
CAD (n)		38 (38%)	9 (21%)	29 (50%)	0.003
Hyperlipidemia (n)		18 (18%)	8 (19%)	10 (17%)	0.5
Medication (n)	ACEIs & ARBs	33 (33%)	7 (17%)	26 (45%)	0.002
	β Blockers	56 (56%)	17 (40%)	39 (67%)	0.006
	CCBs	19 (19%)	9 (21%)	10 (17%)	0.3
	Diuretics	14 (14%)	6 (14%)	8 (14%)	0.5

Statins	43 (43%)	11 (33%)	32 (50%)	0.003
HR (bpm)	74 ± 15	65 ± 7	81 ± 10	<0.000
PR Interval (ms)	164 ± 18	154 ± 15	172 ± 17	<0.000
QRS Duration (ms)	113 ± 10	107 ± 31	118 ± 16	0.001
QT Interval (ms)	452 ± 63	415 ± 16	478 ± 16	<0.000
QTc Interval (ms)	471 ± 47	444 ± 13	492 ± 15	<0.000
LAA (n)	16 (16%)	2 (5%)	14 (24%)	0.007
LVH (n)	24 (24%)	5 (12%)	19 (33%)	0.01
LBBB (n)	3 (3%)	0	3 (5%)	0.1
RBBB (n)	6 (6%)	3 (7%)	3 (5%)	0.4
Normal ECG findings (n)	26 (26%)	21 (50%)	5 (9%)	<0.000
EF (%)	52 ± 14	60 ± 7	46 ± 8	<0.000
LAD (cm)	3.7 ± 0.8	3.2 ± 0.6	4.1 ± 0.7	<0.000
E vel (cm/sec)	87 ± 4	85 ± 5	89 ± 6	<0.003
A vel (cm/sec)	74 ± 13	66 ± 5	79 ± 7	<0.000
EDT (ms)	232 ± 42	208 ± 12	250 ± 11	<0.000
E/A Ratio	1.2 ± 0.1	1.2 ± 0.1	1.1 ± 0.1	<0.000
S.E' (cm/sec)	7.9 ± 3.3	9.8 ± 1	6.4 ± 0.5	<0.000
L.E' (cm/sec)	7.9 ± 3.3	9 ± 0.8	6.5 ± 0.6	<0.000
S E/E' Ratio	11 ± 5	8.7 ± 1	13.8 ± 1.5	<0.000
L E/E' Ratio	11 ± 5	8.7 ± 1	13.8 ± 1.9	<0.000

3.2 Group Comparison

Early diastolic flow velocity (E vel) and atrial contraction velocity (A vel) were longer in patients of the second group. Moreover, acceleration time (EDT) was longer in patients of the first group when compared to their counterparts in the second group (212 × 195). The ratio between the two diastolic speed values (E/A ratio) was comparable between the two groups (1.2 × 1.1).

Tissue velocities; Septal and lateral (S.E', L.E'), were shorter in the first group in comparison with the second one. Recorded ratios between tissue velocities to early diastolic transmitral flow velocity (E vel) had the upper amount in the target group of patients compared with the witness group “Fig.1”,“Fig.2”.

4.

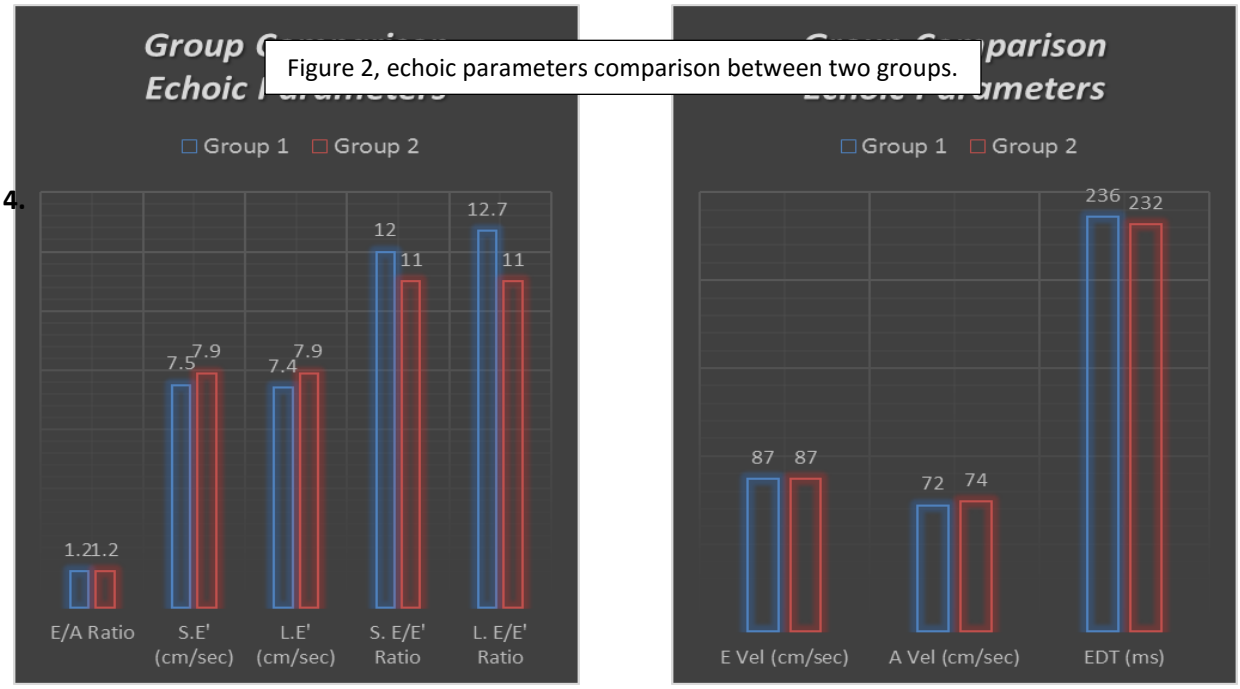

Figure 2, echoic parameters comparison between two groups.

4. DISCUSSION

Through a quick look at what we found in statistical tables and results, we can conclude a number of the following notes. According to the first group, which was complaining symptoms, the presence of diastolic dysfunction, regardless of its subtype, could be linked to the next variable: age, hypertension, diabetes mellitus and coronary artery disease. On the other hand, we did not find any important statistical link within sex or hyperlipid variables. For the used drugs, we got a statistical relation for β blockers, ACEIs and ARBs. Statins, CCBs and diuretics did not have any important statistical value in this group. There was an important relationship between the presence of diastolic dysfunction and all electrical parameters involved in our article, except for the width of QRS complex and the presence of the conduction defect (LBBB-RBBB). In the case of normal ECG, we found a potential link to the presence of diastolic dysfunction. For echoic parameters, we noticed an important statistical relation between all variables and the presence of diastolic dysfunction, except E vel, with the acknowledgment of the marginal p-value of 0.05 that we got.

According to the second group, which was considered the witness group, we found the same results discovered in the target group, except for the following: statins usage, QRS duration and E vel had an important statistical link to the presence of diastolic dysfunction in the second group compared to the first one. We made a deep study on the relationship between the corrected QT interval and the presence of diastolic dysfunction. We chose the corrected form instead of the uncorrected one to avoid the influence of pulse rate. Based on the cluttered diagram; the significant statistical relationship was enhanced at a QTc point of 455 ms in the two groups. Therefore, there is a linear relation between QTc interval and diastolic dysfunction “Fig.3”.

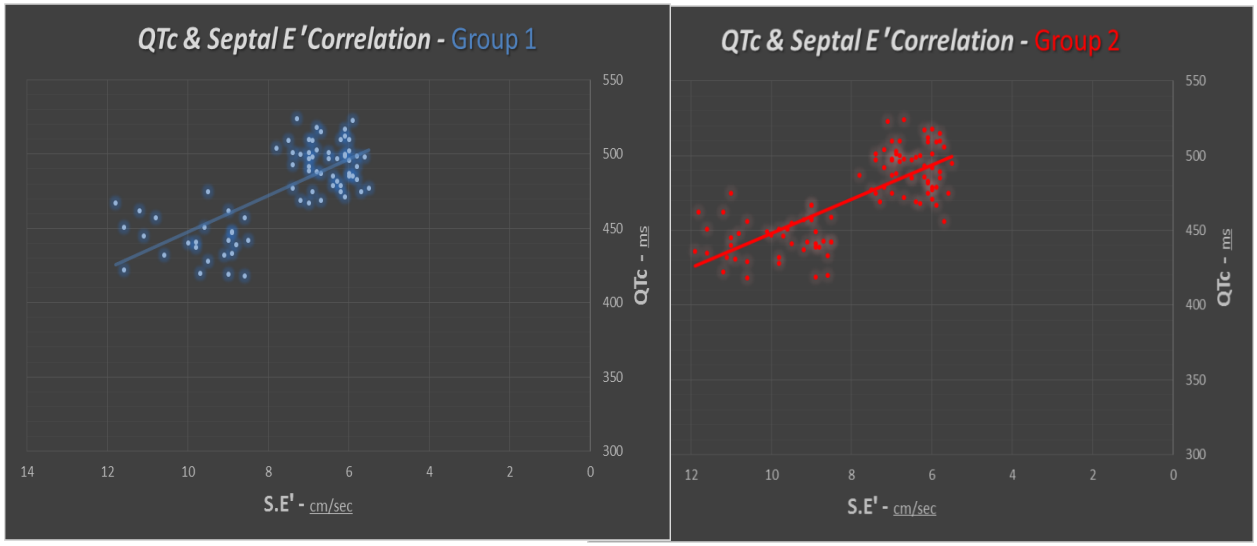

Figure 3, scattered diagram explain the distribution of two variables.

5. CONCLUSION

It is possible to predict the existence of diastolic dysfunction by measuring the corrected QT interval, which is considered an independent factor for predicting of left ventricular relaxation.

The study limitation was the sample size of both groups, because it is considered few in number of patients containing. Another important limitation was the method of collecting data, assuming personal collection of information, and the researcher experience in reading also plays an important role.

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We did not take any written consent from the patients since our article information does not interfere with moral privacy or medical searching literature.

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