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Left Ventricular Functions Assessment by Speckle Tracking in Comparison with The Two-Dimensional (2D) Echocardiography in Patients with Fragmented QRS

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ABSTRACT

Background and Aim: Fragmented QRS (fQRS) are electrocardiographic signals reflecting altered ventricular conduction around regions of a myocardial scar and/or ischemia. However, it could be presented in normal healthy individuals. But, its incidence and its role in prediction of cardiac disease is not yet addressed. This study aiming to assess the left ventricular (LV) functions in patients with apparent normal LV functions with fQRS using two-dimensional (2D) speckle tracking echocardiography.

Patients and Methods: This cross-sectional study take place from March to October 2020. Fifty non cardiac patients who undergo preoperative cardiac assessment of non-cardiac surgery at cardiology department were included. All subjects are submitted to full history taking, complete general and local examinations, twelve lead ECG searching for fQRS complex and exclude ischemia and arrhythmia, and transthoracic echocardiography to assess LV functions as described previously.

Results: 36% fQRS complex was in anterior lead, 50% were in Inferior lead and only 14 % was in Lateral lead. Mean EF was 58.9 ± 5.8%, ranging from 55 to 65, FS was 26.7±1.9%, with range of 24 to 40%. LVEDD 4.5±0.7cm, LVESD was 3.3±0.4cm, Intraventricular septum was 10.1±0,6 mm and Posterior wall thickness 9.6±07 mm. Left ventricular longitudinal strain in 2 chamber apical view was 16.4±3.3%, 4 chamber apical view was 16.7±3%, apical long axis view was 17.7±3.5% and average LV GLS was 18.1±2.9%. There were 15 cases abnormal LV diastolic function according to E/e` ratio and 9 cases according to LV-GLS. There was statistically significant different between assessment of LV function by 2D echocardiography and speckle tracking.

Conclusion: The presence of fQRS on standard electrocardiography in apparently healthy people with preserved EF is associated with some sort of subclinical LV dysfunction and two-dimensional speckle tracking is more accurate and sensitive than two-dimensional echocardiography in detection of those patients.

Keywords: **Ejection Fraction; Speckle Tracking; Global Longitudinal Strain; Left Ventricular Function**.

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INTRODUCTION

Fragmented QRS (fQRS) are electrocardiographic signals reflecting an altered ventricular function around regions of a myocardial scar and/or ischemia [1]. fQRS may be a reliable marker of previous myocardial ischemia in the absence of Q waves. In addition, fQRS has been linked to arrhythmic events in patients with Brugada syndrome, non-ischemic cardiomyopathy and coronary artery ectasia [2]. fQRS is observed for 7.2% of healthy individuals. It is also presented at a higher rate in patients with cardiac diseases such as myocardial infarction (MI) with ST elevation (21.9%), chronic renal failure (60%), cardiac sarcoidosis (75%) and metabolic syndrome (26.1%) [3].

It has been reported that the presence of fQRS on a routine electrocardiogram (ECG) can give a reasonable indicator for the severity of cardiac involvement in different cardiac and/or systemic diseases [4]. Two-dimensional speckle tracking echocardiography (2D-STE) is a relatively new introduced method, which enable more reliable and complete myocardial function assessment by obtaining the myocardial strain and strain rates in the longitudinal, radial and circumferential directions based on the tracking of speckles in gray scale two-dimensional (2D) echo-cardiographic images [5].

Strains and strain rates, parameters representing the amount and rate of myocardial deformation can detect early subclinical changes in the myocardial systolic and diastolic functions [6].

In previous literature, the longitudinal were deteriorated earlier than radial and circumferential functions in myocardial dysfunction. Longitudinal strain thus offers a quantitative analysis of the myocardial deformation of each LV segment. In addition, it permits for the early detection of systolic dysfunction in patients with preserved LV ejection fraction (LVEF) [7].

This study aimed to assess the LV functions in patients with fQRS using two-dimensional speckle Tracking Echocardiography. In addition, to compare between 2D STE and conventional 2D echocardiography in assessment of those patient.

PATIENTS AND METHODS

This cross-sectional study take place from March to October 2020. Fifty non cardiac patients (Convenient sample) who undergo preoperative cardiac assessment of non-cardiac surgery at cardiology department. Al-Azhar University Hospital (New Damietta) and achieving eligibility criteria were invited to participate in our study, after explaining study aims and their verbal consent were approved. The inclusion criteria were: patients with apparently preserved LVEF and fQRS complexes. On the other side, exclusion criteria were: ischemic heart disease either by history or investigation; more than mild degree of valvular stenosis or regurgitation; poor quality echo-cardiographic views; patients with a history of cardiomyopathy and LV hypertrophy (LVH), pathological Q wave on electrocardiogram, typical left or right bundle blocks, incomplete right bundle block, or paced rhythm, previous cardiac surgery, diabetes mellitus, hypertension, chronic kidney disease, smoking and obesity. All subjects are submitted to full history taking, complete general and local examinations, twelve lead ECG searching for fQRS complex and exclude ischemia and arrhythmia [8], and transthoracic echocardiography to assess left ventricular function as described in Nagueh et al. [9], El-Sebae et al. [10] and Hung et al. [11]

Statistical Analysis: Quantitative normally distributed data were expressed as an average and standard deviation (SD). Frequency and percentage were the measures for qualitative data. Suitable analytic tests were used according to the type of data. For example, Wilcoxon Signed rank test used to compare left ventricular dysfunction between speckle tracking and two-dimensional echocardiography. P-value <0.05 was considered statistically significant. The SPSS software, version 16 (SPSS Inc, Chicago, IL, USA) was used to complete all statistical analysis.

RESULTS

The current work included 50 subjects; their age ranged between 41 and 63 years of age and the majority of them were win their fifties. Males were 54% and body mass index reflected normal values for all subjects (ranged between 18 and 24.2 kg/m2). At presentation, the heart rate ranged between 69 and 94 beats/minutes, and both systolic and diastolic blood pressure were in normal values. The fragment QRS shown in 36% in the anterior lead, 14% in the lateral lead and 50.0% in the inferior lead (Table 1).

Echocardiography examination revealed normal values, as ejection fraction ranged between 50 and 65%, LVEDD ranged between 3.9 and 5.2 cm, while LVESD ranged between 3 and 4 cm. The interventricular septum ranged between 9.6 to 11 mm, while posterior wall thickness ranged between 9.8 to 11.1 mm and fraction shortening percentages ranged between 24 and 40% (see table 2 for detailed results of echocardiography, doppler flow measures and tissue velocity imaging).

Table (3) showed results of the two-dimensional speckle tracking and left ventricular global longitudinal strain ranged between 14 and 22%, the mean value was 18.1±2.9%

As regard to LV dysfunction, there was 15 cases abnormal LV diastolic function according to E/e` ratio and 9 cases according to LV-GLS (Table 4).

Table (1): Demographic Characters and clinical presentation among study group

			Statistical measures
Age (years)		Mean±SD; Min.-Max	55.9 ± 6.7; 41 - 63
Sex (n, %)		Male	27 (54 %)
		Female	23 (46%)
BMI (kg/m²)		Mean±SD; Min.-Max	21.18 ± 2.2; 18-24.2
Clinical data	HR (beat/min.)	Mean±SD; Min.-Max	80.6 ± 12.4; 69-94
	SBP (mmHg)	Mean±SD; Min.-Max	116 ± 7.1; 110-130
	DBP (mmHg)	Mean±SD; Min.-Max	75.1 ± 5.8; 70-85
	Fragmented QRS in Anterior lead	N,%	18 (36%)
	Fragmented QRS in Lateral lead	N,%	7 (14%)
	Fragmented QRS in Inferior lead	N,%	25 (50%)

Table (2): Echocardiography, Doppler flow measures and tissue velocity imaging among study groups

			Statistical measures
Echocardiography	EF (%)	Mean±SD; Min.-Max	58.9 ± 5.8; 50 – 65
	LVEDD (cm)	Mean±SD; Min.-Max	4.5 ± 0.7; 3.9 – 5.2
	LVESD (cm)	Mean±SD; Min.-Max	3.3 ± 0.4; 3-4
	Intraventricular septum (mm)	Mean±SD; Min.-Max	10.1 ± 0.6; 9.6 - 11
	Posterior wall thickness (mm)	Mean±SD; Min.-Max	10.6 ± 0.6; 9.8 – 11.1
	FS (%)	Mean±SD; Min.-Max	26.7 ± 8.11; 24 - 40
Doppler flow measures	E wave (cm/sec)	Mean±SD; Min.-Max	7±0.9; 6-8.1
	A wave (cm/sec)	Mean±SD; Min.-Max	6±0. 1; 5.6-6.7
	E/A ratio	Mean±SD	0.96±0.1
	DT (ms)	Mean±SD; Min.-Max	229.8±21.1; 217-250
Tissue velocity imaging	E/e`(cm/sec)	Mean±SD; Min.-Max	6.8 ± 3.9; 5-17

E wave; Early diastolic velocity, A wave; late diastolic velocity; E/e` for Velocity of the mitral annulus early diastolic wave

Table (3). 2D speckle tracking among study groups

LV-GLS	Mean ± SD	Range
2 Chambers %	16.4 ± 3.3	14 – 19
4 Chambers %	16.7 ± 3	15 – 21
Apical Long Axis %	17.7 ± 3.5	15 – 20
Average GLS %	18.1 ± 2.9	14 – 22

LV-GLS; left ventricular global longitudinal strain.

Table (4). Frequency of LV dysfunction among study groups

	Normal	Abnormal
EF	50 (100.0%)	0 (0.0%)
E/e`	35 (70.0%)	15 (30.0%)
LV-GLS	41 (82.0%)	9 (18.0%)

NB: percentages were calculated from the rows

Table (5). Comparison between LV function assessment by 2D echocardiography and Speckle tracking.

	Normal LVF	Test	P-value
EF	50 (100.0%)	3.0	0.003*
LV-GLS	41 (82.0%)		

LVF; left ventricular function.

DISCUSSION

fQRS complexes are seen on electrocardiogram as signals denoting altered ventricular function. Its prevalence is about 7.2%, but the prevalence rate increased with presence of different cardiac and non-cardiac systemic diseases. The introduction of echocardiography enables the detection of subclinical LV dysfunction. The newest 2D STE used to analyze the speckles movement on the 2-D gray scale ultrasound images of the myocardium. It had the advantages of being non-user or angle-dependent and not affected by cardiac motion. It also provides data about the segmental function, and it seems to be a useful technique to detect

LV functions [12]. Previous studies have shown that the presence of fQRS may be associated with LV dysfunction at different cardiac situations [7]. These complexes are shown to be linked to intraventricular systolic desynchrony and subendocardial fibrosis in nonischemic cardio-myopathy [1]. The study of Dehghani *et al*. [13], found that the existence of fQRS on standard 12-lead ECG in healthy individuals is significantly associated with the lower values of GLS compared to individuals without fQRS.

The study of Nikoo *et al*. [14] found that fQRS was associated with regional LV systolic dysfunction irrespective of normal ejection fraction and fQRS should not be treated as an innocent finding in healthy individuals. Kaya *et al*. [15] found that there was association between fQRS and subclinical systolic and diastolic dysfunction in cases with preserved EF. The study of Bayramoğlu *et al*. [16] found that fQRS in smokers can be used to detect LV subclinical systolic and diastolic dysfunction.

The present study was trying to answer the following question, could a fQRS has a relation with LV dysfunction and could 2D STE be accurate than conventional 2D echocardiography in detection of subclinical LV dysfunction in patients with Preserved EF. In this cross-section study, we found in individual with preserved LV function associated with fQRS in routine cardiovascular screening using a 12-lead stander ECG, 2D Echocardiography and speckle tracking. LV-GLS was significantly more accurate than 2D echocardiography in assessment of LV function in patient with fQRS. In our study, the mean age of sample was 52.9 ± 6.7 years and 54% was male. Clinical character of our participants showed that heart rate was 80.6 ± 12.4 beat per min, SBP was 116 ± 7.1 mm Hg and DBP was 75.1 ± 5.8 mm Hg in contrast with Dehghani et al., patients with fragmented QRS clinical characters were 76.5 ± 9.4 beat per min, SBP 118.5 ± 10.5 mm Hg and DBP was 70.4 ± 7.3 mm Hg [13].

12- lead standard ECG in this study showed that the fQRS frequency was 50 % in inferior lead, 14% in lateral lead and 36% was in ± anterior lead; which in agreement with Bayramoğlu *et al*. [16], as they demonstrate that the 50 % of cases showed fQRS in inferior lead, 12.5% in lateral lead and 37.5% was in anterior lead.

As regard to echocardiographic M mode parameters, we found that the EF was 58.9 ± 5.8 %, LVESD was 3.3±0.4cm, LVEDD 4.5 ± 0.7cm, intraventricular septum thickness 10.1 ± 0.6mm, posterior wall thickness was 10.6 ± 0.6mm and FS was 26.7 ± 1.9%. which supported by Bayramoğlu *et al*. [3], study whom found that patients with fQRS complex had EF of 58.9 ± 3.8%, LVESD was 3.3 ± 0.6 cm, LVEDD 4.5 ± 0.3 cm, intraventricular septum thickness 10.3 ± 0.6mm and posterior wall thickness was 10.6 ± 0.9 mm. And study of Dehghani *et al*. [13] found that in patients with positive fQRS complex had EF of 59.6 ± 2.4%, LVEDD 4.8 ± 0.3cm, intraventricular septum thickness 1±0.1mm and posterior wall thickness was 0.9 ± 0.08 mm. In study of Yaman *et al*. [12], patients with fQRS complex had EF of 61.94± 2.18%, LVEDD 4.54±0.3 cm, LVESD was 3.14±0.28 cm, intraventricular septum thickness 0.94±0.18 mm and posterior wall thickness was 0.9 ± 0.11 mm.

The Doppler flow measures are in line with study of Kaya *et al*. [15], who illustrate that the early diastolic velocity was 7 ± 0.5cm/sec, late diastolic velocity was 6.7 ± 0.6cm/sec and E/A ratio was 1.15±0.17.

In our study the early diastolic velocity was 7±0.9 cm/sec, late diastolic velocity was 6±0.1cm/sec and E/A ratio was 1.15±0.17. Dehghani *et al*. [13] found that the early diastolic velocity was 0.7±0.06 cm/sec, late diastolic velocity was 0.5±0.7 cm/sec and E/A ratio was 1.2±0.1. In study of Yaman *et al*. [12], the early diastolic velocity was 0.67±0.14 cm/sec, late diastolic velocity was 0.65±0.15 cm/sec and E/A ratio was 1.10±0.37.

Mitral valve deceleration time was 229.8±21.1 ms in agreement with Dehghani *et al*. [13], declaration time was 228.8±21.1 ms.

As regard tissue velocity imaging Bayramoğlu *et al*. [3], found that the velocity of the mitral annulus early diastolic wave was 7.8±2.4 cm/sec in agreement with our results 7.8±1.9 cm/sec. In study of Yaman *et al*. [12], Mitral valve deceleration time was 241.13±45.25 ms.

By 2DSTE in patients with preserved EF and positive fQRS Dehghani *et al*. [13], demonstrate that the GLS 2-chamber was 16.9±2.5%, GLS 4-chamber 16.9±3.4%, GLS LAX 17.7±2.8% and average GLS was 17±2.6%. We had found the GLS 2-chamber was 16.4±3.3%, GLS 4-chamber 16.7±3%, GLS LAX 17.7±3.5% and average GLS was 18.1±2.9%. In the study of Yaman *et al*. [12], GLS in 180 healthy individuals with fQRS was 19.62±3.05%.

According to the frequency of detected LV dysfunction there was no abnormality detected by all parameter except 30% of cases was lower than normal value in Doppler flow measures and 18% of cases showed lower GLS value.

The current study showed agreement with study of Dehghani *et al*. [13]; they studied 54 patients aiming to determine the association between the fQRS presence in apparently healthy subjects without overt cardiovascular diseases and had a preserved LVEF LV function using 2-dimensional transthoracic echocardiography (2D-TTE) with the application of tissue Doppler imaging (TDI) and STE. Their patients were categorized into two groups, 26 had positive fQRS and 28 had negative fQRS in baseline ECG. Patients with fQRS had significantly reduced values of apical LV global longitudinal strain (LV GLS) in 2-chamber (16.9±2.5 vs. 20.5±3.3), 4-chamber (16.9±3.4 vs. 20.1±3), LAX views (17.7±2.8 vs. 20.8±3.5), and

averaged LV GLS (17±2.6 vs. 20.4±2.7) values than patients without fQRS. Dehghani *et al*.[13] showed a lower GLS values in individual with fQRS.

This study showed agreement with the study of Nikoo *et al*.[14] who included 20 subjects with fQRS (study group) and 20 peers without fQRS (as controls) Global LV GLS was measured by STE in the two groups 14 subjects out of 40 had reduced GLS (≤20%) and 10 of them (25%) had fQRS. GLS was significantly lower in the group with fQRS than in the control group (19.9±1.8 vs 21.4±1.6; p=0.009). Another study of Bayramoğlu *et al*.[16], found lower GLS value in healthy smoker with fragmented QRS. In comparison of using 2D echocardiography and speckle tracking we didn't find in literature study compare between using 2D echocardiography and speckle tracking in patient with fQRS, in other hand our results statistically support using of speckle tracking in assessment of LV function in patient with fQRS (p= 0.000).

At the end of this study we can say that fQRS normally present in healthy people and in people with subclinical LV dysfunction. This study demonstrates that the presence of fQRS on standard ECG in apparently healthy people with preserved EF is associated with some sort of subclinical LV dysfunction and significant lower values of LV by 2D STE compared to 2D echocardiography. However, the small sample of included subjects representing a limiting step for globalization of these results. Future large-scale studies are recommended.

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