Al-Azhar Med. J .(Cardiology). *Vol. 50 (1), January, 2021, 559 - 568*
DOI: 10.12816/amj.2021.139836
https://amj.journals.ekb.eg/article_139836.html

EVALUATION OF LEFT VENTRICULAR DEFORMATION PARAMETERS IN INDIVIDUALS WITH EARLY REPOLARIZATION PATTERN BY 2D SPECKLE TRACKING ECHOCARDIOGRAPHY

By

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ABSTRACT

Background: The prevalence of early repolarization (ER) pattern in standard12-lead electrocardiography is as high as 13% in the general population. Although ER pattern was considered to be a benign electrocardiographic variant, several case–control and epidemiological studies have shown that it is associated with an increased risk of idiopathic ventricular fibrillation (VF) and death.

Objective: To detect whether there is any abnormality in the myocardial deformation parameters (global longitudinal strain and circumferential strain) of the left ventricle using 2D Speckle Tracking Echocardiography (STE) in individuals with early repolarization pattern.

Patients and methods: This was a prospective observational study that was conducted from January 2019 to June 2020 and included 60 cases recruited from General Transport Authority Hospital pre-employment files, with 30 patients with early repolarization pattern as a study group, and 30 individuals without early repolarization pattern as a control group who underwent conventional and 2D speckle tracking echocardiography.

Results: There was no statistically significant difference between groups according to age and BMI. The mean age of control and ER groups were 26.90±3.53&25.30±4.40 respectively. Heart rate was higher in subjects with ER pattern (73.03±6.17 & 79.03±7.95 for control and ER groups respectively).There was a statistically significant difference between their studied groups regarding E/E' (6.58±0.66 Vs 5.53±0.81) for control and ER groups respectively. There was no statistically significant difference between groups according to LV longitudinal strain (-21.3±1.62 Vs -19.73±2.35) for control and ER groups respectively. There was no statistically significant difference between groups according to LV circumferential strain (-18.97±1.03 Vs -20.73±2.18) for control and ER groups respectively.

Conclusion: In healthy subjects with ER pattern, LV myocardial deformation by STE was comparable to control group with no statistically significant differences between both groups. There was no correlation between global longitudinal and circumferential strains and age, body mass index, heart rate, LV mass index, diastolic parameters and ejection fraction.

Keywords: Left ventricular deformation parameters,Early repolarization pattern, 2D Speckle Tracking Echocardiography.

INTRODUCTION

The prevalence of early repolarization syndrome (ERS) in the general population varies from <1% to 13%, depending on age (predominant in young adults), race (highest among black populations), sex (predominant in males), and the criterion used to measure J-point elevation (0.05 vs. 0.1 mV). In patients with documented idiopathic VF and a structurally normal heart, the overall prevalence of ERS is approximately 31%. However, the prevalence of the ERS pattern with J-wave elevation ≥0.2 mV in patients with idiopathic VF was found to be 16%. The prevalence of early repolarization is significantly higher than previous estimates among asymptomatic young adults, and the majority of early repolarization regressed by middle age. It seems that black race, lower body mass index, lower serum triglyceride levels, and longer QRS duration are independently associated with maintenance of early repolarization over time *(Walsh et al., 2013)*.

A meta-analysis of these studies showed that the risk ratio was 1.70 (95% confidence interval [CI]: 1.19–2.42; p=0.003) for arrhythmic death in patients with ER. The prevalence of early repolarization (ER) pattern in standard 12-lead electrocardiography is as high as 13% in the general population, and it is relatively common in young adults, males, African descents, and athletes. A meta-analysis of these studies showed that the risk ratio was 1.70 for arrhythmic death in patients with ER *(Wu et al., 2013)*.

Morphological and structural myocardial adaptations to exercise have been largely studied by echocardiography. The secondary LV remodeling to load training consists of an increased LV wall thickness and an augmented LV cavity dimension with preserved systolic and diastolic function. Although the normal upper limits of the athlete's heart have been established, there is still a grey zone where physiological heart adaptation overlaps with cardiac diseases implicated in exercise-related sudden cardiac death *(Chelliahand Senior, 2010)*.

Speckle-tracking echocardiography (STE) is a relatively new imaging technique that is increasingly used in the evaluation of global and regional myocardial functions. It is largely independent from ultrasound beam angle and cardiac translational movements. It allows the assessment of myocardial deformation parameters in different spatial directions (i.e., longitudinal, radial, and circumferential) *(Mondillo et al., 2011)*. Some studies have shown that STE can be used in different clinical situations to evaluate cardiac mechanics in a feasible, reproducible, and accurate way *(Kalogeropoulos et al., 2012)*.

The main objective of our study was to detect any abnormality in the myocardial deformation parameters (global longitudinal strain and circumferential strain) of the left ventricle using 2D Speckle Tracking Echocardiography in individuals with early repolarization pattern.

PATIENTS AND METHODS

This was a prospective observational study that was conducted from January 2019 to June 2020 and included 60 cases.

Inclusion Criteria:

Patients with early repolarization pattern was defined as a J-point elevation of ≥0.1mV in at least two contiguous leads with either a QRS slurring or notching at 12 lead ECG, and early repolarization pattern.

Exclusion Criteria:

1. Patients with arrhythmias as atrial fibrillation, advanced atrioventricular block, left or right bundle branch block or paced rhythm.Patients with moderate to severe valvular heart disease.
2. Patients with EF < 50 %.
3. Patients with history of CAD either a history of acute coronary syndrome, PCI or CABG or regional wall motion abnormalities suggestive of CAD by two-dimensional Echocardiography.
4. Patients with poor echocardiographic window.

All studied populations were subjected to:

1. Informed verbal consent.
2. History taking with stress on risk factors of age, gender, smoking, HTN…etc.
3. Body mass index (BMI) for all subjects.
4. Complete physical examination (BP, heart rate (HR), chest and cardiac examination).
5. Laboratory investigations including CBC, renal & liver functions, and cholesterol profile.
6. Standard 12 lead ECG to detect the presence of early repolarization pattern was defined as a J-point elevation of ≥0.1mV in at least two contiguous leads with either a QRS slurring or notching at 12 lead ECG *(Obeyesekere et al., 2013).*
7. Conventional Echocardiographic examination *(Lang et al., 2015).*
8. 2D Speckle tracking echocardiography study Automated delineation of endocardial borders was obtained through marking the endocardial and epicardial borders. The area of interest was manually adjusted if automated delineation was not optimal. Segments with poor image acquisition or artifacts were excluded due to inability to measure CS *(Mondillo etal., 2011).*

Statistical analysis:

Recorded data were analyzed using the statistical package for the social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD).Independent-samples t-test of significance was used when comparing between two means. Pearson's correlation coefficient (r) test was used to assess the degree of association between two sets of variables. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant when : P-value <0.05.

RESULTS

There was no statistically significant difference between groups regarding to age and body mass index. All studied population were males Comparison between control group and ER group according to demographic data. Statistically significant difference was between groups regarding to heart rate and E/E'. No statistically significant difference between groups regarding to E/A, EF and LV mass index. Comparison between control group and ER group according to Doppler and dimensional echocardiographic measurement **(Table1)**.

Table (1): Demographic data of the diflerent groups.

Groups / Demographic data	Control group (n=30)	ER Group (n=30)	p-value
Age (years) Mean±SD	26.90±3.53	25.30±4.40	>0.05
BMI [wt/(ht)^2] Mean±SD	24.74±1.87	23.88±2.12	>0.05
Groups / Parameters	Control group (n=30)	ER Group (n=30)	p-value
Doppler measurements:	Mean±SD	Mean±SD	
HR (beat/min)	73.03±6.17	79.03±7.95	0.018*
E/A	1.52±0.20	1.33±0.18	>0.05
E/E'	6.58±0.66	5.53±0.81	<0.001
Dimensional echocardiographic measurements:			
EF%	64.30±2.38	63.27±2.30	>0.05
LV mass Index (g/m2)	80.50±11.78	78.17±8.92	>0.05

t-Independent Sample t-test;
t-Independent Sample t-test;

No statistically significant difference between groups regarding to LV longitudinal strain either globally or regionally and no statistically significant difference between groups regarding to LV circumferential straineither globally or regionally **(Table 3)**.

Table (2): Comparison between control group and ER group according to LV longitudinal and LV circumferential strain rate

Groups / Parameters	Control group (n=30)	ER Group (n=30)	p-value
LV Longitudinal Strain:	Mean±SD	Mean±SD	
Apical 4 chambers view	-21.57±2.03	-19.73±2.66	<0.004
Apical 2 chambers view	-20.87±2.01	-19.40±3.23	<0.004
Apical 3 chambers view	-21.77±2.18	-19.23±2.79	<0.001
Global longitudinal strain	-21.30±1.62	-19.73±2.35	<0.004
LV Circumferential Strain:			
At Papillary muscle level (M)	-16.87±1.50	-19.83±3.03	<0.001
At Mitral level (B)	-19.10±1.65	-20.00±3.70	0.229
At Apical level (A)	-20.73±3.68	-22.27±3.96	>0.05
GlobalCircumferential strain	-18.97±1.03	-20.73±2.18	<0.001

t-Independent Sample t-test;

There was a positive correlation and significance between global LV circumferential strain with EF%, while there was no significant correlation between global LV Longitudinal strain and global LV circumferential strain with age, BMI, heart rate, LV mass index, E/A and E/E' **(Table 3)**.

Table (3): Correlation between Global LV Longitudinal Strain and Global LV Circumferential Strain with Age , BMI, Heart rate , LV mass Index (g/m2), EF%, E/A and E/E'

Types of Strain / Parameters	LV Longitudinal Strain Rate [Global strain rate]		LV Circumferential Strain Rate [Global strain rate]	
	R	p-value	r	p-value
Age (years)	0.283	0.130	0.351	0.057
BMI [wt/(ht)^2]	0.152	0.424	-0.240	0.201
Heart rate (beat/min)	-0.052	0.784	-0.233	0.215
LV mass Index (g/m2)	0.080	0.674	-0.290	0.121
EF%	0.018	0.924	0.384	**0.036***
E/A	0.244	0.194	-0.338	0.067
E/E'	-0.046	0.810	0.019	0.919

r-Pearson Correlation Coefficient

DISCUSSION

In this study, there was no statistically significant difference between groups according to age and BMI. Our results were in agreement with study of *Sinner et al. (2010)* as they reported that there was no statistically significant difference among the studied groups as regard BMI.

The present study showed that there was a statistically significant difference between groups according to heart rate and E/E'. Our results were in line with study of *Gülel et al. (2016)* as they reported that there was a statistically significant difference between their studied groups regarding heart rate and E/E'. Heart rate was higher in subjects with ER pattern.

STE was shown to allow the pre-clinical detection of cardiac dysfunction before deterioration of traditional echocardiographic parameters. Angle independency, semiautomatic nature, lack of geometric assumptions, and ability to obtain information regarding global and regional cardiac functions in different spatial directions are the major advantages of this technique *(Forsey et al., 2013)*.

The current study showed that there was no statistically significant difference between groups according to LV longitudinal strain either globally or regionally. Our results were supported by study of *Gülel et al. (2016)* as they did not observe significant differences between the groups for LV longitudinal deformation parameters. Peak strain, systolic strain rate, early diastolic strain rate, and late diastolic strain rate values were all similar.

MRI may be considered the reference standard in this area of study, its routine use is limited by its high costs, poor availability, relative complexity of acquisitions, and time-consuming image analysis (Geyer et al., 2010).

In the present study, there was no statistically significant difference between groups according to LV circumferential strain either globally or regionally. No statistically significant correlation between global LV longitudinal strain with age, BMI , heart rate, LV mass Index (g/m^2), EF%, E/A and E/E'. There is positive correlation and significance between LV Global Circumferential Strain with EF%, while the rest were insignificant. Our results were supported by study of *Gülel et al. (2016)* as they demonstrated that some LV myocardial deformation parameters obtained by STE were different between the groups.

Sauer et al. (2014) evaluated the repolarization heterogeneity and found an independent relationship between heterogeneity of electrical repolarization and that of contraction duration in the radial direction by strain imaging. This may be the case in subjects with ER pattern, causing regional alterations in LV myocardial deformation parameters.

There are too few echocardiographic studies done in individuals with electrocardiographic ER pattern. *Wilhelm et al. (2010)* investigated the influence of ER pattern on diastolic function and left atrial size in professional soccer players. Players with ER pattern had a lower heart rate, a higher E/E' ratio, and larger left atrial volumes compared to players without ER pattern. In our study, however, individuals with ER pattern had a higher heart rate, decreased E/E' ratio, and similar left atrial dimension compared to those without ER pattern. This discrepancy may be partly explained by the fact that professional soccer players have a higher vagal tone causing lower heart rate and higher LV filling pressure. They also evaluated LV longitudinal deformation parameters. They found that there was no difference between the groups for global longitudinal strain, systolic strain rate, and diastolic strain rate values.

Stankovic et al. (2014) evaluated the value of two-dimensional speckle-tracking-derived strain to distinguish acute coronary syndrome from a marked early repolarization. Speckle-tracking strain analysis revealed normal longitudinal peak systolic strain in all segments of inferior wall, ruling out wall-motion abnormalities in that region. At follow-up, no evolution of ECG findings was detected. In addition, coronary angiogram and serial cardiac biomarkers were normal. ER pattern was responsible for ECG findings of the patient and quantification of regional LV function was successfully performed by speckle-tracking analysis.

Aagaard et al. (2014) conducted a study with the aim of assessing prevalence and patterns of ER in middle-aged long-distance runners, its relation to cardiac structure and function, and its response to strenuous physical activity. There was no difference between the subjects with versus without ER pattern for interventricular and posterior wall thicknesses, LV dimensions, mass, and ejection fraction. However, the E/A ratio was higher in runners with ER pattern. In addition, there were differences in the vecto-cardiographic parameters between the subjects. For this, the authors explained that exercise training led to an increase in parasympathetic modulation.

Verdugo-Marchese et al. (2020) stated that Absolute GLS value was lower in the longest QRS quartile and shortest QTc quartile. Time-to-peak of strain was not significantly different according to QRS duration although significantly higher in patients with higher QTc. MD was significantly greater in patients with longer QTc.

CONCLUSION

There was no correlation between global longitudinal and circumferential strains and age, body mass index, heart rate, LV mass Index, diastolic parameters and ejection fraction. Further studies are recommended to show the potential clinical value of myocardial deformation in early repolarization patients who associated with cardiovascular diseases as coronary or valvular heart disease.

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تقييم أنماط التشوه في عضلة البطين الأيسر للقلب في الأشخاص الذين لديهم نمط عودة الإستقطاب المبكر على رسم القلب الكهربائى باستخدام موجات القلب فوق الصوتية ذات التتبع النقطى ثنائى الأبعاد

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خلفيـة البحـث: تبلـغ نسـبة انتشـار متلازمـة عـودة الاسـتقطاب المبكـر حـوالى 1% الـى 13% مـن تعـداد السـكان العـام، وتعتمـد هـذه النسـبة علـى عـدة عوامـل منهـا السن(تسـود فـى البـالغين) والعرق(اعلـى فـى الاشـخاص ذوى البشـرة السـوداء) والجنس(فـى الـذكور أكثـر مـن الانـاث) والخصـائص المسـتخدمة لقيـاس ارتفـاع النقطـة(J.0.1 mV Vs 0.05 mV) وتعتبـر موجـات القلـب فـوق الصـوتية ذات التتبـع النقطـى ثنـائى الأبعـاد تقنيـة حديثـة نسـبياً، وتسـتخدم بصـورة متزايـدة فـى تقيـيم وظـائف القلـب العامـة والمنطقيـة، وتتميـز بأنهـا لا تعتمـد بصـورة كبيـرة علـى زاويـة سـقوط أشـعة الموجـات فـوق الصـوتية التقليديـة وتسـمح بتقيـيم معـايير التشـوه فـى عضـلة القلـب مـن الجهـات الفراغيـة المختلفـة(طولى ومحيطـى وشـعاعى) وتشـمل معايير التشوه: الازاحة والسرعة والإجهاد ومعدل الإجهاد والدوران.

الهـدف مـن البحـث: دراسـة معـايير التشـوه فـى البطـين الأيسـر فـى الأشـخاص ذوى نمـط عـودة الاسـتقطاب المبكـر باسـتخدام موجـات القلـب فـوق الصـوتية ذات التتبـع النقطى ثنائى الابعاد.

المرضـي وطـرق البحـث: تـم إجـراء هـذه الدراسـة فـى قسـم أمـراض القلـب بكليـة طـب الازهر وشملت هذه الدراسة 60 مريضاً تم تقسيمهم إلى:

1. **حـالات الدراسـة:** أشـخاص لـديهم نمـط عـودة الاسـتقطاب المبكـر علـى رسـم القلب القياسى.
2. **حـالات ضـابطة:** أشـخاص لـيس لـديهم نمـط عـودة الاسـتقطاب المبكـر علـى رسـم القلب القياسى.

وقد خضعت كل حالة للسؤال عن التاريخ المرضى باستفاضة وفحص سريرى كامل ورسم قلب كهربائى وأشعة عادية على الصدر وأشعة بالموجات فوق بالاضافة إلى الفحوصات المعملية وبعد ذلك بوبت وجدولت المعلومات وحللت إحصائياً.

نتائج البحث: لم توجد أى فروق ذات دلالة إحصائية بين المجموعتين من حيث السن ومعدل كنلة الجسم حيث بلغ متوسط السن26.9±3.53 و25.3±4.4 على التوالى .وجد فروق ذات دلاله إحصائيه بين المجموعتين من حيث معدل ضربات حيث أن معدل ضربات القلب كان مرتفعاً فى الاشخاص ذوى نمط E/È القلب نسبة عودة الاستقطاب المبكر (مجموعه الدراسه).وأظهرت الدراسة كذالك عدم فروق ذات دلاله إحصائيه بين المجموعتين من حيث معدل الاجهاد الطولى للبطين الايسر ،وكانت هذه النتائج متوافقه.كذلك اظهرت الدراسه عدم وجود اى فروق ذات دلاله إحصائيه بين المجموعتين بالنسبه لمعدل الاجهاد المحيطى للبطين الايسر.كما وجد ارتباط ايجابى وجوهرى بين الاجهاد المحيطى للبطين الايسرومحيط الاورطي (مم (EF%).(مع كفاءة عضله القلب.

الإستنتاج: لدى الاشخاص ذوى نمط عودة الإستقطاب المبكر والذين تم دراسة معايير التشوه فى البطين الأيسر بواسطة موجات القلب فوق الصوتية ذات التتبع النقطى ثنائى الأبعاد معايير طبيعية مع بعض الاستثناءات المنطقية بالمقارنة مع الأشخاص العاديين والذين ليس لديهم نمط عودة الإستقطاب المبكر.