Role of speckle tracking Echocadiography in differentiation between ischemic and idiopathic dilated cardiomyopathy

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Abstract: **Introduction:** Different types of cardiomyopathies should be differentiated noninvasively as it carries therapeutic and prognostic purposes**. Aim of the work:** detect the role of speckle tracking echocardiography in differentiation between ischaemic and dilated cardiomyopathy. **Material and methods:** Eighty patients presented with recent history of dyspnea with depressed left ventricular systolic function (EF ≤ 40 %) subjected to speckle tracking echocardiography and myocardial perfusion imaging and results of patients were compared to results of coronary angiography which allows differentiation of the patients into two groups, group 1 Ischemic group and group 2 Non ischemic group. **Results**: there was statistically significant difference between the two groups as regard global and segmental longitudinal strain and strain rate parameters, GLS in group I (mean ± SD -10.68 ± 2.7) versus (mean ± SD -5.85 ± 1.41) in group II with P value < 0.001, and GLSR in group I (mean ± SD -0.93 ± 0.16) versus (mean ± SD -0.68 ± 0.12) in group II with P value < 0.001. Speckle tracking Echocardiography (GLS 17) has higher specificity 100 % with low sensitivity 52.5 % in diagnosing CAD. **Conclusion:** Speckle tracking echocardiography is considered a useful noninvasive tool for differentiation between ischemic and dilated cardiomyopathy with higher specificity and low sensitivity. **Recommendations:** The STE technique should be applied for patients with LV dysfunction for detection of CAD.

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1. Introduction

Patients with severe left ventricular (LV) dysfunction due to ischemic cardiomyopathy or nonischemic dilated cardiomyopathy may have similar clinical presentations[2]. The noninvasive differentiation of underlying etiology in these patients might be difficult but important, as the treatment and prognosis differ 3. There is an increasing need for diagnostic modalities able to objectively quantify myocardial function. Quantification of regional myocardial function with ultrasound is challenging on its own. Visual assessment of wall motion and thickening requires extensive training and remains highly subjective 3. Tissue deformation imaging is introduced technique which enables the objective assessment of regional myocardial deformation assessed by ultrasound based strain and strain rate using myocardial Doppler data or B-mode images. This is a promising technique to quantify regional left and right ventricular function and appears of added value in unmasking or unraveling cardiac pathology.

Knowledge of its principles and limitations is mandatory for proper application and reliable interpretation of the results both in the clinical as well as the scientific 4.

2. Material and methods

The present study included (80) subjects presented with recent history of dyspnea with depressed left ventricular systolic function (EF ≤ 40 %) at our cardiovascular department at Al-Hussein and Bab EL-She'riya University Hospitals – Al-Azhar University – Cairo – Egypt between March 2014 and August 2016, were considered to participate in this study.

They were subjected to full history taking, clinical examination, laboratory investigations, Echocardiography including speckle tracking and tissue Doppler imaging, myocardial perfusion imaging and coronary angiography. The patients were classified according to coronary angiography results in to two groups:

Group (A) Ischemic cardiomyopathy: 40 patients with significant coronary artery disease.

Group (B) Nonischemic cardiomyopathy: 40 patients with normal coronary angiography.

The study excluded patients with prior myocardial infarction, prior coronary interventions, left ventricular ejection fraction > 40%, atrial fibrillation, significant primary valvular heart disease, congenital heart disease, technically poor acoustic

window for transthoracic echocardiography and patients with contraindication for exercise myocardial perfusion.

All of them were subjected Informed written consent, complete history taking high lightened onset, course and duration of dyspnea, provocating and relieving factors, functional capacity, NYHA class and history of chest pain, diabetes, hypertension, smoking, drug history, chemotherapy, past history of myocardial infarction, coronary intervention, and family history with complete physical examination.

All examinations were performed using a commercial lyavailable equipment A Philips IE 33 X Matrix phased array system equipped with TDI & STE technology, using a multi frequency (1 - 5 MHz) S5-1 matrix array probe was used. All the patients were examined in the left lateral decubitus position. Echocardiographic images were acquired from the standard views (parasternal long-axis, parasternal short axis at papillary muscle level, apical four –chamber, apical five –chamber and apical two-chamber, apical three chambers). Recordings and calculations of different cardiac chambers and ejection fractions were made according to the recommendations of the American Society of Echocardiography 6. Echocardiographic examination was done to all the study population including Two-dimensional echocardiography to measure LVESD, LVEDD from parasternal long axis view and EF was calculated using biplane Simpson method according the last American society of echocardiography recommendation. 2-D Speckle tracking echocardiography study:

The study in all patients was done after coronary angiography. The following views were taken for later analysis; apical 4 chamber view, apical 2 chamber view, and apical long axis view.

In blinded post-processing, longitudinal deformation had been assessed by speckle tracking, being measured the segmental peak systolic longitudinal strain (SLSS) and strain rate (Sr) for the 17 segment LV model from the apical 4-chambers, 2-chambers and long axis views, with high frame rates (> 60 frames/s) using commercial imaging analysis software (Philips IE 33 software).

End-systole was defined as aortic valve closure in the apical long-axis view by continuous Doppler wave recording. Automated delineation of endocardial borders was obtained through marking the mitral annulus level and at the apex on each digital loop. 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 LS.

Segmental longitudinal peak systolic strain (SLS) closing for the basal, mid ventricular and apical segments and averaged from the all segments to provide global peak longitudinal systolic strain (GLS) for the 17 and 12 segments.

In each segment peak longitudinal systolic strain rate (Sr) and average from the all segments to provide Sr 17 and 12 segments were measured7.

Myocardial perfusion imaging

Single-photon emission computed tomography Gated-SPECT studies was performed using a two-day Stress/rest protocol for detection of myocardial ischemia. patients underwent qualitative and semi quantitative SPECT, following intravenous administration of 20-25 mCi Tc-99m Sestamibi at peak exercise, and In the next day intravenous administration of 20-25 mCi under resting condition. To minimize gall bladder activity, the patients were instructed to consume a fatty meal after Sestamibi injection. Computed tomography images were acquired one hour after infusion of the radiotracer. Image acquisition was achieved with a dual head gamma camera (Siemens) without attenuation or scatter correction, using a low energy, all-purpose collimator. Transaxial tomograms were reconstructed for each patient, at short-axis, horizontal and vertical long axis slices and were analyzed. A total of 17 myocardial segments per patient were studied.

All images were reviewed by two experts; both were unaware of the other reading results by qualitative and semi-qualitative analysis. Topographic images were collected from three planes:

Short axis slices from apex to base of the heart were divided into four apical segments (apical anterior, apical septal, apical inferior and apical lateral), six mid-ventricular segments (mid anterior, mid antero-septal, mid infero-septal, mid inferior, mid posterior and mid lateral), and six basal segments (basal anterior, basal antero-septal, basal infero-septal, basal inferior, basal posterior and basal lateral). Vertical long axis slices from septum to lateral wall. The apical portion of the slice midway between the septum and lateral wall represents the apical segment resulting in a total 17 segments for every patient (16 from short axis and 1 from the vertical long axis views) without duplication of the same anatomic area on different projection 8.

Coronary angiography

Coronary angiography was performed by the percutaneous femoral approach. Coronary angiograms were obtained for each coronary vessel in at least two projections Lesion locations were assessed and percent diameter stenosis was measured for each coronary lesion according to the American Heart Association classification. We assessed the number of affected vessels, using a cutoff of percent diameter stenosis ≥70% for three epicardial vessels and ≥50% for LM coronary artery. The analysis of the coronary

angiograms was performed visually by an experienced operator who was blinded to the results of the echocardiographic examinations (9).

All data were collected and statistically analyzed using Chi-square test using SPSS (Statistical package for social science) software.

3. Results

Table (1) clinical data of studied subjects.

Variables		*ICM* (N = 40)	*NICM* (N = 40)	*p*
Sex	Male	23 (52.3%)	21 (52.5 %)	0.82
	Female	17 (47.2%)	19 (47.5 %)	
HTN	No	20 (43.5%)	26 (56.5%)	0.69
	Yes	20 (58.8%)	14 (41.2%)	
DM	No	20 (50.0%)	18 (45.0%)	0.82
	Yes	20 (50.0%)	22 (55.0%)	
Smoking	No	25 (62.5%)	19 (47.5%)	0.26
	Yes	15 (37.5%)	21 (52.5%)	
NYHA class	I	16 (40.0%)	5 (12.5%)	**0.01**
	II	18 (45.0%)	24 (60.0%)	
	III	6 (15.0%)	11 (27.5%)	

The present study included 80 cases with recent history of dyspnea and reduced EF ≤ 40 % who were divided into two groups 40 patients with significant coronary disease and 40 patients with normal coronary angiography. In group A, mean age was 54.8 years old with 23 (57.5%) male and 17 female (42.5 %), 15 smoker (37.5 %), 25 non smoker (62.5 %). 20 patients with hypertension and 20 patients with normal blood pressure, 20 patients with diabetes mellitus and 20 patients without DM, mean heart rate 86.4 bpm, 16 patients (40 %) have NYHA functional class I,18 patients (45 %) have NYHA functional class II,6 patients (15 %) have NYHA functional class III.

In group B, mean age was 55.2 years old with 21 (52.5 %) male and 19 female (47.5 %), 19 smoker (47.5 %), 21non smoker (52.5 %).14 patients with hypertension and 26 patients with normal blood pressure, 22 patients with diabetes mellitus and 18 patients without DM, mean heart rate 85 bpm, 5 patients (12.5 %) have NYHA functional class I,24 patients (60 %) have NYHA functional class II,11 patients (27.5 %) have NYHA functional class III.

Table (2): that shows baseline characteristics between studied patients.

Parameters		M ± SD			*P*
Age	ICM	54.80	±	9.26	0.836
	NICM	55.23	±	9.04	
HR	ICM	86.43	±	9.45	0.511
	NICM	85.00	±	9.84	
SBP	ICM	124.75	±	23.64	0.851
	NICM	125.75	±	23.95	
DBP	ICM	74.63	±	18.45	0.802
	NICM	75.63	±	16.99	

Table (3): Comparison of some conventional echocardiographic parameters between the two groups.

Parameters		*M ± SD*			*P*
LVIDD	ICM	6.96	±	0.79	0.852
	NICM	6.99	±	0.76	
LVIDS	ICM	5.25	±	0.81	0.425
	NICM	5.12	±	0.69	
EF (M mode)	ICM	29.83	±	6.71	0.294
	NICM	28.33	±	5.97	
LVEDV	ICM	164.55	±	28.06	**0.003**
	NICM	182.20	±	23.04	
LVESV	ICM	63.53	±	8.22	**< 0.001**
	NICM	78.85	±	8.99	
EF (Simpson's)	ICM	32.58	±	4.98	**0.006**
	NICM	29.63	±	4.27	
E	ICM	90.98	±	19.93	0.175
	NICM	96.88	±	18.61	
Em	ICM	5.90	±	1.24	0.368
	NICM	5.68	±	0.97	
E/Em	ICM	15.86	±	4.61	0.237
	NICM	17.09	±	4.64	

There was statistically significant difference between the two groups as regard LVESV, LVEDV and EF measured by Simpson's method.

Table (4): comparison between two groups as regard strain parameters.

Strain parameters		*M ± SD*			*P*
Apex	ICM	-5.63	±	3.60	0.230
	NICM	-4.83	±	2.14	
AA	ICM	-6.80	±	3.65	**0.045**
	NICM	-5.50	±	1.72	
AL	ICM	-12.95	±	6.03	**< 0.001**
	NICM	-5.98	±	2.03	
AI	ICM	-12.28	±	6.74	**< 0.001**
	NICM	-5.23	±	1.82	
AS	ICM	-5.98	±	2.26	**0.091**
	NICM	-5.23	±	1.61	
ML	ICM	-11.28	±	4.74	**< 0.001**
	NICM	-6.15	±	1.73	
MP	ICM	-10.85	±	5.65	**< 0.001**
	NICM	-5.60	±	1.60	
MI	ICM	-11.90	±	6.48	**< 0.001**
	NICM	-6.08	±	1.07	
MIS	ICM	-12.13	±	5.61	**< 0.001**
	NICM	-5.60	±	1.61	
MAS	ICM	-9.80	±	4.33	**< 0.001**
	NICM	-5.15	±	1.35	
MA	ICM	-10.63	±	3.99	**< 0.001**
	NICM	-5.70	±	1.44	
BIS	ICM	-11.15	±	4.09	**< 0.001**
	NICM	-6.20	±	1.20	
BAS	ICM	-10.83	±	3.92	**< 0.001**
	NICM	-5.85	±	1.48	
BA	ICM	-11.13	±	4.16	**< 0.001**
	NICM	-6.80	±	1.24	
BI	ICM	-12.25	±	4.46	**< 0.001**
	NICM	-5.08	±	1.37	
BL	ICM	-12.18	±	3.87	**< 0.001**
	NICM	-5.08	±	1.31	
BP	ICM	-12.10	±	3.98	**< 0.001**
	NICM	-5.30	±	1.24	
GLS 17	ICM	-10.68	±	2.70	**< 0.001**
	NICM	-5.85	±	1.41	
GLS 12	ICM	-14.93	±	3.33	**< 0.001**
	NICM	-4.98	±	2.29	

There was no statistically significant difference between the two groups as regard age, heart rate, systolic or diastolic blood pressure.

There was statistically significant difference between the two groups as regard global and segmental longitudinal strain parameters with GLS 17 in ischemic group -10±2.7 versus -5.8 ± 1.4 in non ischemic group with p value < 0.001.

There was statistically significant difference between the two groups as regard global and segmental longitudinal strain rate parameters with GLSr 17 in ischemic group -0.93± 0.16 versus -0.68 ± 0.12 in non ischemic group with p value <0.001.

Table (5): Comparison between the two groups as regard strain rate parameters.

SR parameters		*M ± SD*			*P*
Apex	ICM	-0.45	±	0.04	**< 0.001**
	NICM	-0.35	±	0.05	
AA	ICM	-0.51	±	0.18	**0.003**
	NICM	-0.38	±	0.19	
AL	ICM	-0.93	±	0.30	**< 0.001**
	NICM	-0.42	±	0.06	
AI	ICM	-1.04	±	0.71	**< 0.001**
	NICM	-0.38	±	0.08	
AS	ICM	-0.70	±	0.38	**< 0.001**
	NICM	-0.29	±	0.20	
ML	ICM	-0.66	±	0.30	**< 0.001**
	NICM	-0.40	±	0.10	
MP	ICM	-0.70	±	0.39	**< 0.001**
	NICM	-0.36	±	0.09	
MI	ICM	-0.78	±	0.45	**1.000**
	NICM	-0.78	±	0.45	
MIS	ICM	-0.82	±	0.49	**1.000**
	NICM	-0.82	±	0.49	
MAS	ICM	-0.88	±	0.26	**1.000**
	NICM	-0.88	±	0.26	
MA	ICM	-0.90	±	0.21	**1.000**
	NICM	-0.90	±	0.21	
BIS	ICM	-0.88	±	0.25	**1.000**
	NICM	-0.88	±	0.25	
BAS	ICM	-0.89	±	0.39	**1.000**
	NICM	-0.89	±	0.39	
BA	ICM	-1.15	±	0.46	**< 0.001**
	NICM	-0.74	±	0.23	
BI	ICM	-1.07	±	0.15	**< 0.001**
	NICM	-0.78	±	0.18	
BL	ICM	-1.33	±	0.24	**< 0.001**
	NICM	-0.75	±	0.20	
BP	ICM	-1.07	±	0.27	**< 0.001**
	NICM	-0.79	±	0.17	
GLSr 17	ICM	-0.93	±	0.16	**< 0.001**
	NICM	-0.68	±	0.12	
GLSr 12	ICM	0.95	±	0.17	**< 0.001**
	NICM	-0.80	±	0.13	

Table (7) Validity of speckle tracking (GLS 17) in diagnosing CAD among the studied sample.

Cutoff point	≥ – 11
AUC	0.945
Sensitivity	52.50 %
Specificity	100.00 %
Positive predictive value	100.00 %
Negative predictive value	67.8 %

Global longitudinal strain 17 segments derived from 2D speckle tracking echocardiograph is considered a valid parameter for diagnosing ischemic cause of left ventricular dysfunction with higher specificity 100 % and low sensitivity 52.5 %.

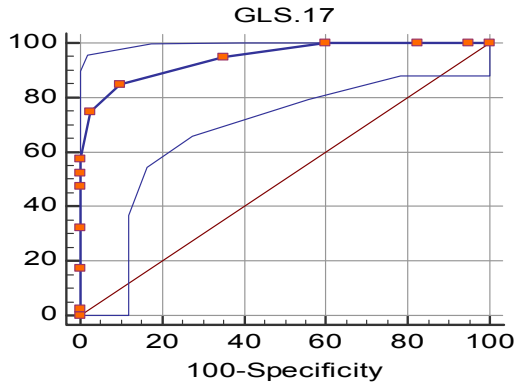

Figure (1) ROC curve for validity of GLS in diagnosing CAD

4. Discussion

Our data indicate that global longitudinal strain parameter of speckle tracking echocardiography can accurately distinguish between the clinical entities of left ventricular dysfunction secondary to coronary artery disease and nonischemic causes of cardiomyopathy. Echocardiographers who had no access to clinical information were able to distinguish the two subgroups of cardiomyopathy on the basis of visual analysis of strain and starin rate measures with acceptable accuracy. Quantitative analysis of the images resulted in detection of ischemic cardiomyopathy with a sensitivity of 53 % and specificity of 100%. Patients diagnosed as having nonischemic cardiomyopathy on the basis of coronary arteriographic findings had lower values of strain and strain rate or more homogeneity the strain of all myocardial segments.

Thus, speckle tracking echocardiography can be utilized as a noninvasive technique to distinguish the etiology of severe left ventricular dysfunction. The sensitivity, specificity and predictive value of this technique are comparable with and probably superior to those of most other noninvasive techniques because of the lesser degree of overlap in defects between the clinical subgroups.

Myocardial strain is a measure of myocardial deformation (10) which allows for the assessment of specific local and global function. The fibers of the human left ventricle are arranged in a complicated fashion, with epicardial fibers in a left-handed helix, endocardial fibers in a right-handed helix from apex to base and midwall fibers in horizontal arrangement (11) Therefore, heart movement during systolic phase includes longitudinal shorting motion in the direction of fiber orientation from base to apex, (1) radial motion in which a gradient of wall thickening exists across vetricular wall from epicardium to endocardium, (13) circumferential motion in which each fiber-plane contracts on circumferential shortening in short-axis, and rotation and twist motion as the apex rotates with respect to the base between different layers of myocardium around LV long-axis. On the basis of standard grey-scale images, STI can identify characteristic speckles within the myocardium and track them frame-by-frame to yield 2D images of tissue deformation, reflecting the deformation of the different myocardial segments within the ROI. Instead of focusing solely on longitudinal deformation, STI allows for the study of other components of myocardial contraction, namely, radial, circumferential, rotational movement, and for the assessment of LV global and regional systolic function (12).

Clinical relevance of findings: role of speckle tracking echocardiography. The availability of a noninvasive modality for distinguishing nonischemic dilated cardiomyopathy from cardiomyopathy secondary to coronary artery disease is of clinical importance. Management of the latter group entails diagnostic arteriography with surgical revascularization if suitable, whereas the approach in the former group is generally with medical therapy. In most instances, the clinical history of angina with enzyme documented myocardial infarction or the lack thereof can distinguish between the two subgroups with cardiomyopathy. However, it is not rare to encounter a clinical situation where multiple risk factors for coronary artery disease are present and the ECG is nondiagnostic for infarction due to an interventricular conduction defect or shows evidence of infarction, thus suggesting a diagnosis of left ventricular dysfunction due to multiple asymptomatic myocardial infarctions.

Conclusion

This study concluded that 2D speckle tracking echocardiography can be utilized as a specific noninvasive test for the differentiation between ischaemic and dilated cardiomyopathy with a higher specificity and lower sensitivity.

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