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Impaction of coronary artery ectasia on left ventricular systolic function by global longitudinal strain: Using two-dimensional speckle tracking echocardiography

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Abstract

Background: A type of coronary vasculopathy called coronary artery ectasia (CAE), which is identified in around 5% of individuals undergoing coronary angiography, particularly in males, should not be taken lightly. This study used two-dimensional speckle tracking echocardiography (2D-STE) to assess the effect of CAE on left ventricular systolic function (LVSF) by measuring global longitudinal strain (GLS).

Methods: 30 individuals with ectasia in one or more coronary arteries but no severe coronary artery stenosis served as the ectatic group in this prospective case-control research, whereas 30 individuals with normal coronary angiography results served as the control group. Either typical angina or favourable findings from stress testing served as the justification for coronary angiography.

Results: T The average global peak longitudinal systolic strain (GPLS) was reduced to a greater or lesser extent depending on the number of vessels and segmental areas impacted in the ectatic group. A statistically substantial variation was existed as regard LV internal diameter, all readings of GPLS of the affected segments except for segment 5, (Left circumflex artery, right coronary artery, and left anterior descending) segments average. In the GPLS normal group, there was a large rise in single vessel affection, whereas the GPLS abnormal group had a considerable rise in three vessel affection.

Conclusions: A non-invasive imaging technique called 2D-STE that measures longitudinal systolic strain may help identify early signs of left ventricular systolic malfunction.

Keywords: Left ventricular systolic function, coronary artery ectasia, global longitudinal strain, speckle tracking echocardiography

Introduction

The rare coronary artery disorder known as coronary artery ectasia (CAE) is characterised by the aberrant widespread dilatation of one or more coronary artery segments to 1.5 times or more the size of the neighbouring normal section of the artery [1]. The word "ectasia" indicates widespread dilatation of a coronary artery, while the phrase "coronary aneurysm" refers to focused dilatation [2]. Since the illness often has no symptoms, it is typically only accidentally identified during cardiac examinations for disorders including coronary artery disease (CAD), stable angina, and additional acute coronary syndromes [3]. The incidence of CAE during coronary angiography ranged from 1-5% and has even been observed to approach 10% in individuals with ischemic heart disease (IHD) [4]. Although there is a strong correlation among atherosclerosis and CAE, particularly in the west, the histological variations and inconsistent reports of the conventional cardiovascular a indicator of risk lessen the importance of this link [5]. Numerous research linked CAE to inflammation. In addition, coronary ectasia was linked to traditional cardiovascular indicators of risk like smoking, hypertension, and hyperlipidaemia [6]. The clinical relevance of CAE is unclear. There isn't a prevalent symptom that CAE might be connected to. positive stress tests, Angina pectoris, or acute coronary syndromes may still occur among individuals with CAE who have only little coronary stenosis [7].

The evaluation of left ventricular systolic functioning (LVSF) offers crucial information for cardiovascular condition diagnosis, therapy strategies, and prognosis. The most widely utilised method for quantitatively estimating LVSF in routine clinical practise is transthoracic echocardiography. The most popular techniques for this reason have been region wall motion analysis and left ventricular ejection fraction. The utilisation of new parameters to measure LVSF has been made possible by the development of new technologies, such as cardiac magnetic resonance imaging, computed tomography, and novel ultrasound modalities (speckle tracking imaging, tissue Doppler imaging, and three-dimensional echocardiography) [8]. Even though resting 2-dimensional echocardiography displays normal functioning, it may identify subclinical impacts on the myocardium using echocardiographic deformation imaging methods, particularly those that quantify strain and strain rate [9]. Since the longitudinal muscle fibres of the myocardium are directly impacted by alterations in the pressure within the ventricle and the coronary circulation, deterioration of their function immediately appears. As a consequence, measuring strain rate and longitudinal strain could be sensitive in detecting left ventricular impairment at the preclinical stage. [10]

The goal of this research was to assess the effect of CAE on LVSF by measuring global longitudinal strain (2D-STE) utilising speckle tracking.

Patients and Methods

This prospective case-control work was carried out on 30 individuals had normal coronary angiography results and 30 had coronary arteries with one or more ectasias but no substantial coronary artery stenosis. Positive findings from stress testing or classic angina were the two signs that coronary angiography was necessary.

After receiving clearance from the ethical committee at Tanta University Hospitals in Egypt, the research was carried out. Between June and December 2020. Participants provided signed permission after being fully briefed.

Criteria for exclusion were the presence of significant coronary artery stenosis (stenosis greater than 50%), warning signs of pericardial and valvular cardiac diseases via echocardiography, LV ejection fraction <50%, additional CAE-causing conditions (syphilis, Kawasaki disease, connective tissue disorders, Marfan's syndrome, primary cardiac lymphoma, arteritis) identified by coronary CT angiography, inadequate echocardiogram image quality.

Two equally sized groups of individuals were formed: Participants in the ectatic group have ectasia in one or more coronary arteries but do not have any substantial stenosis.

Participants in the control group had typical coronary angiography results.

Each participant had a taking of history, a thorough physical examination, 2D speckle tracking echocardiography with global longitudinal strain (GLS), a standard and 2D conventional echocardiogram, and an electrocardiogram.

Electrocardiogram

To identify myocardial ischemia, left ventricular hypertrophy (LVH), and myocardial infarction, it was performed on every participant utilising a paper speed of 25 mm/s and a standardisation of 1 mV/10 mm.

The Cornell's guidelines (R wave in aVL + S wave in V3 > 28mm in men and >20mm in women) were used to assess LVH.

The Framingham criterion (R aVL> 11mm, R V4-V6 > 25mm) or the Sokolow Lyon criterion (SV1 + R in V5 or V6 >35mm). (100)

2D conventional echocardiography

It was carried out using a 3Sc probe having 2.5 MHz variable frequencies harmonic phased array transducers and synchronous ECG signals (vivid 9, General Medical System, Horton, Norway).

Left lateral decubitus had been the posture used to examine each patient.

Standard Images were taken in the apical (two, three, and four chamber views) and parasternal (long axis and short axis views).

Conventional echocardiography

2D, Regular M mode, pulsated, and continuous wave Doppler data have been obtained for each instance during conventional echocardiography. By using two-dimensional targeted m-mode echo monitoring in parasternal long axis views, LV inner cavity measures, the left atrial (LA) span, LV ejection fraction %, and LV fractional decrements have been evaluated.

Every measurement was carried out in accordance with the standards of the American Society of Echocardiography (ASE).

Global Longitudinal Strain (GLS) with 2D speckle tracking ECHO

The collection of the best 2D photos, image storage, transport to a special workstation, and post-study evaluation are all included.

With STE evaluation, electrocardiogram gating will be used. In all individuals with typical sinus rhythm, an ideal signal must show 3 cardiac cycles with almost similar heart rates. The 2D pictures that are obtained determine the STE analysis's quality.

Apical views: The apical 2-chamber view, apical 4-chamber view, and apical long axis view (AP2ch, AP4ch, and APLAX) were used to get the longitudinal strain assessment. In the left lateral decubitus position, the individual was positioned. To eliminate foreshortening, the apical window was selected because it shows more bullet-shaped ventricles and has the longest base to apex length. Participants were then instructed to hold their breath during each scan to get accurate strain data. In an LV focused view with the depth reduced to just beneath the mitral annulus, the focus for these pictures produced good quality grey scale images with the correct gain settings. A sector's breadth was kept track of. When using frame rates between 40 and 90 Hz, which are suitable for the majority of strain analysis programme packages, the left ventricular walls and apex were not removed from the picture sector. The 3 cardiac cycles were suggested, giving the analyst a variety of beat alternatives to consider. Continuous wave (CW) Doppler pictures with aortic valve closure (AVC) click were taken after all three two-dimensional views had been acquired.

For the 6 midventricular, 6 basal, and 5 apical segments, segmental longitudinal peak systolic strain was recorded in all views between aortic valve closure and opening. To give

GLS, the average longitudinal peak systolic strain of these segments was automatically determined.

Statistical analysis
SPSS v26 (IBM Inc., Armonk, NY, USA) was used for the statistical evaluation. The mean and standard deviation (SD) of the quantitative parameters were reported, and they were compared for the same group using a paired Student's t-test. Frequency and percentages (%) were used to illustrate qualitative parameters. The Shapiro-Wilk test was employed to determine if the data distribution was normal. For comparing parametric and non-parametric continuous data across groups (among participants), independent sample T and Mann Whitney tests were employed, correspondingly. Utilising the crosstabs tool, the Fisher exact and Chi square tests were applied to compare nominal data across groups. Significant results were defined as two tailed P values < 0.05.

Results
No substantial variation was existed among both groups under study as regard the body mass index, mean age, blood pressure, Heart rate. Table 1

Table 1: Demographic data, Heart rate, blood pressure of the studied groups

Parameters		Ectatic group n=30	Control group n=30	test of significance
Age/years		53.33±4.06	51.13±6.92	t=1.50 p=0.139
Sex	Male	25 (83.3%)	10(13.3%)	P<0.001 *
	Female	5 (16.7%)	20(66.7%)	
Diabetes mellitus		4 (13.3%)	15(50%)	p=0.002 *
Hypertension		23 (76.7%)	14(46.7%)	p=0.017 *
Smoking		9 (30%)	6(20%)	χ^2=0.800 p=0.371
Body mass index		29.96±1.83	29.73±2.08	0.651
Heart rate (bpm)		71.17±2.65	71.63±3.18	t=0.617 p=0.539
Systolic blood pressure (mmHg)		117.0±9.15	115.33±8.99	t=0.711 p=0.480
Diastolic blood pressure (mmHg)		71.33±7.76	72.67±7.85	t=0.662 p=0.511

Data are presented as mean ± SD or frequency (%). *statistically significant

In the control group, the left ventricular end-diastolic dimension (LVIDd) of the patients by m-mode demonstrated statistically substantial variation among groups. Table 2

Table 2: Left ventricular systolic functions by m-mode and modified Simpson's rule of the studied groups:

	Ectatic group n=30	Control group n=30	test of significance
Left ventricular systolic functions by m-mode			
IVSd (cm)	1.15±0.17	0.97±0.69	p=0.000
IVSs (cm)	1.063±0.13	1.073±0.18	t=0.247 p=0.806
LVIDd (cm)	4.68±0.49	5.04±0.33	t=3.36 p=0.001*
LVIDs (cm)	2.91±0.39	3.06±0.24	t=1.78 p=0.081
LVPWd (cm)	1.17±0.148	0.99±0.087	p=0.000
LVPWs (cm)	1.01±0.09	1.02±0.18	t=0.182 p=0.856
EDV (ml)	103.65±25.1	94.97±20.24	t=1.47 p=0.146
ESV (ml)	33.87±10.31	36.30±8.37	t=1.00 p=0.320
FS (%)	39.71±3.59	37.93±2.61	t=0.547 p=0.586
EF (%)	61.70±2.35	62.27±2.61	t=0.883 p=0.381
Left ventricular systolic functions by modified Simpson's			
LVEF (%)	57.86±22.64	64.83±6.87	t=1.62 p=0.112
SV (ml)	88.64±21.75	68.49±18.43	t=0.028 p=0.977
LVEDV (ml)	102.8±32.45	91.10±15.69	t=1.77 p=0.082
LVESV (ml)	37.24±17.46	34.43±6.19	t=0.829 p=0.410
LVLs(cm)	6.89±0.88	6.57±1.06	t=1.30 p=0.198
LVLd(cm)	8.52±1.02	8.25±1.23	t=0.935 p=0.354

Data are presented as mean ± SD. IVSs: Intraventricular septal thickness in systole, IVSd: Intraventricular septal thickness in diastole, LVIDs: Left ventricular Internal diameter in systole, LVIDd: Left ventricular Internal diameter in diastole, LVPWs: Left ventricular posterior wall thickness in systole, EDV: End diastolic volume, LVPWd: Left ventricular posterior wall thickness in diastole, ESV: End systolic volume, EF: ejection fraction, FS: Fractional shortening. *Statistically significant

13 cases have single vessel affection (10 cases RCA, 0 cases LCX and 3 cases LAD) & 9 cases two vessel and 8 cases have three vessel diseases (left circumflex artery (LCX), right coronary artery (RCA), left anterior descending (LAD)). Table 3

Table 3: Ectasia site, classification and number of vessels affected by ectasia among studied cases.

		N=30
RCA	Normal	20(66.7%)
	Mid	15(50.0%)
	Distal	4(13.3%)
	Diffuse	4(13.3%)
LCX	Normal	15(50.0%)
	Mid	9(30.0%)
	Distal	0
	Diffuse	0
LAD	Normal	17(56.7%)
	Mid	11(36.7%)
	Distal	0
	Diffuse	0
Revised classification	III	4(13.3%)
	IVa	9(30.0%)
	IVb	9(30.0%)
	IVc	8(26.7%)
Number of vessels affected by ectasia		
Single vessel	RCA	10 (33.3%)
	LCX	0
	LAD	3(10%)
Two vessels		9(30%)
Three vessels		8(26.7%)

Data are presented as frequency (%), LCX: left circumflex artery, RCA: right coronary artery, LAD: left anterior descending.
All readings show statistically significant difference between groups except for segment 5.

A statistically substantial variation was existed regarding RCA, LCX and LAD segments between groups. A statistically substantial variation was existed regarding GLS segment between groups. Table 4

Table 4: Comparison of peak systolic strain of the affected segments and PLS average and average GPLS in (RCA, LCx and LAD) segments between studied groups:

	Ectatic group n=30	Control group n=30	test of significance
Segment 1	-14.97±1.03	-16.73±3.03	t=3.03 p=0.004*
Segment 2	-14.90±1.32	-17.43±3.34	t=3.86 p<0.001*
Segment 3	-13.07±2.57	-16.83±3.63	t=4.64 p<0.001*
Segment 4	-14.83±2.42	-17.87±3.58	t=3.84 p<0.001*
Segment 5	-16.57±2.11	-17.47±4.83	t=0.935 p=0.354
Segment 6	-16.73±2.43	-14.60±3.5	t=2.74 p=0.008*
Segment 7	-18.67±2.07	-20.5±3.85	t=2.29 p=0.025*
Segment 8	-18.1±1.77	-21.17±3.36	t=4.42 p<0.001*
Segment 9	-16.63±1.85	-19.9±3.754	t=4.28 p<0.001*
Segment 10	-16.63±1.43	-20.97±3.65	t=6.05 p<0.001*
Segment 11	-17.37±1.97	-20.83±4.62	t=3.78 p<0.001*
Segment 12	-17.17±2.07	-19.77±4.03	t=3.14 p=0.003*
Segment 13	-20.6±3.46	-24.3±4.82	t=3.42 p=0.001*
Segment 14	-19.63±2.58	-25.1±4.61	t=5.66 p<0.001*
Segment 15	-19.97±1.77	-24.73±4.62	t=4.35 p<0.001*
Segment 16	-19.07±2.75	-24.73±4.62	t=5.77p<0.001*
Segment 17	-20.63±2.97	-24.5±4.78	t=3.77 p<0.001*
GPLS average	-20 (-23, -15)	-20.35 (-24, -15)	z=1.76 p=0.078
RCA segments average	-16.4 (-18.6,-13.8)	-19.8 (-25.2,-15)	z=5.08 p<0.001*
LCX segments average	-17.2	-19.1	z=2.78 p=0.005*
LAD segments average	-17.7	-21.35	z=3.92 p<0.001*

Data are presented as mean ± SD or median (IQR), GPLS: global peak longitudinal strain, LCX: left circumflex artery, RCA: right coronary artery, LAD: left anterior descending. *Statistically significant

Comparing of ectatic groups' vascular affection numbers. In the GPLS normal group, single vessel affection increased significantly. On the other hand, the GPLS abnormal group had a considerable rise in 3 vessels affection. Table 5

Table 5: Comparison of number of vessels affected by ectasia between ectatic patients (normal and abnormal GPLS).

		GPLS normal n=23	GPLS abnormal n=7	test of significance
Single vessel	Present	13(56.5%)	0	χ 2=6.98 p=0.008*
	Absent	10(42.5%)	7(100%)	
Two vessels	Present	9(39.1%)	0	χ 2=3.91 p=0.047*
	Absent	14(60.9%)	7(100%)	
Three vessels	Present	1 (4.4%)	7(100%)	χ 2=9.13 p=0.002*
	Absent	22(95.6%)	0	

Data are presented as frequency (%), GPLS: global peak longitudinal strain *Statistically significant.

Discussion

A rare form of coronary artery disorder called coronary artery ectasia (CAE) is characterised by aberrant diffuse dilatation of one or more coronary artery segments with a diameter higher than 1.5 times that of the segment next to it that is well [11].

Regarding the mean age, there was no discernible variance between the two analysed groups in the present research. According to Aghajani and Faal's [12] investigation, there was no statistically substantial variation in the ages of the two groups.

Similarly to Dogdus' research, Kucukosmanoglu's [11] analysis found no statistically substantial variation in age among the two groups.

Males made up the majority of the coronary ectasia patients in the current research.

These findings are consistent with a research by Amirzadegan and Davoodi [13] that included 229 CAE individuals at the Tehran Heart Centre and found that men had a two-fold greater risk of developing the disease.

The risk factors for CAD include smoking, stress [7], diabetes mellitus [15], hypertension [14], and BMI [16].

In this study smoking demonstrated no substantial variation among both groups.

Also, in Aghajani, Faal [12] study, no statistically substantial variation was existed among both groups as regard smoking history.

Males are more prone to smoke than females, and the percentage of males in the CAE group was much greater than that in the normal coronary group. This is the reason why the CAE group had a greater prevalence of cigarette smoking.

The occurrence of diabetes was higher in the control group than in the ectatic group in this research, which may establish the link between CAE and diabetes and shown a substantial variation among the two groups.

In other studies, a negative connection between CAE and DM has been noted. [17] This could be as a result of matrix metalloproteinase being down regulated in response to atherosclerosis with negative remodelling.

Contrarily, the relationship between CAE and factors including smoking, familial history of CAD, hypertension, diabetes mellitus, and hyperlipidemia is up for discussion. [18]

In our research, the ectatic group had a considerably higher incidence of hypertension than the control group.

Similar to Yang, Yang [19] there was a significant correlation with hypertension.

The present study results had revealed that the majority of the ectatic group presented with unstable angina while only 4 cases presented with inferior myocardial infarction. The ECG was normal in unstable angina cases while there were abnormal Q waves in the inferior leads (II, III, avf) in patients with inferior myocardial infarction.

Similar to Malviya, Jha [20] study in which majority of patients presented with angina. They reported that Myocardial infarction, angina, and sudden cardiac deaths are just a few of the clinical symptoms that individuals with CAE presented with. The most frequent presentation is stable angina, and 20% of symptomatic individuals needed several hospital admissions.

Stable angina remains the most typical manifestation in CAE individuals, according to Aboeata and Sontineni [7].

There was a highly statistically substantial variation among two ectatic groups (normal & pathological GPLS) in the current study's segmental longitudinal strain of the afflicted coronary artery region. Regarding the angiographic pattern for individuals in the ectatic group with impacted ectatic segments, as well. In all, just one coronary artery was affected, with the RCA being implicated in 10 (33.3%) individuals and the LAD affecting three (10%). In 9 (30%) individuals, there was involvement of two coronary arteries. In eight (26.7%) individuals, 3 ectatic coronary arteries were implicated.

The ectatic group in the current investigation was divided into two groups. According to the number of coronary arteries affected, 23 individuals with normal GLPS average were divided into three groups: 13 individuals with single coronary artery involvement, 9 individuals with two coronary artery involvement, one individual with three coronary artery involvement, and 7 individuals with three coronary artery involvement.

In order to minimise the significance of GLPS avg as an indicator of LV systolic dysfunction, we discovered that the number of segments damaged in each coronary artery must be more than one in each of the three arteries.

Limitations: The sample size was somewhat limited, and there was insufficient follow-up to assess the predictive significance of the LV function indices generated from 2D-STE. Other strain values (radial and circumferential strain) weren't assessed in this investigation, and information on the medications patients took and their effects on clinical outcomes wasn't accessible.

Conclusions

Assessment of longitudinal systolic strain by 2D-STE is a non-invasive imaging modality that can provide early detection of LV systolic dysfunction in individuals with CAE, especially in individuals with multi-vessels and multi-segments affection.

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Conflict of Interest: Nil

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