Original Research Article

Speckle Tracking Echocardiography for the Assessment of Coronary Artery Disease Severity in Stable Angina Pectoris

Abstract:

Background: In individuals with stable angina, the myocardial strain estimated by 2-D speckle tracking echocardiography (STE) corresponds with the severity of coronary angiography. Significant coronary artery disease (CAD) is an independent predictor of global longitudinal strain.

Aim: The goal of this research is to observe the contribution of STE to the assessment of CAD severity in patient with stable angina pectoris.

Patients & Methods: The study is a prospective one which conducted at Tanta university hospital included forty consecutive patients.

Results: There is inverse correlation between Global Longitudinal Strain (GLS) and Gensini Score. The study revealed that there is significant correlation between GLS and both DM and HTN but there is insignificant correlation between GLS and sex, dyslipidemia and smoking. The study revealed that diabetes and smoking are the most significant risk factors associated with high Gensini score respectively. The study revealed no significant correlation between age and GLS. The study revealed that 1 and 2 coronary vessel disease associated with less significant GLS than 3 and 4 coronary vessel disease. The study revealed that LAD, LCX and RCA are the most frequently affected coronaries respectively. The study revealed that sensitivity of STE in detection of LAD lesions severity was higher than that of LCX and RCA respectively. The study revealed that specificity of STE in detection of LAD lesions severity was higher than that of RCA and LCX respectively.

Conclusion: In addition to ECG and biomarkers, echocardiography is also recommended for the acute and chronic assessment of CAD. This work has helped to pave the way for future research on myocardial strain, which promises to be a cost-effective, noninvasive diagnostic tool for cases with stable angina.

Key word: Speckle Tracking Echocardiography, Coronary Artery, Stable Angina Pectoris

Introduction:

Speckle tracking echocardiography (STE) is an echocardiographic imaging technique used in the disciplines of cardiology and medical imaging to assess the movements of heart tissue utilizing the speckle pattern found in the cardiac muscle or blood when viewed with ultrasound. Each region of the cardiac muscle has a distinct speckle pattern that enables the region to be followed from one frame to another, and this is constant at least from one picture to next. This may be followed sequentially from frame to another in post-processing and finally resolved into angle-independent 2D and 3D strain-based effects [4]. Strain is defined as the change in the size of an item relative to its initial size [5]. Strain rate may also be seen as the rate at which deformation happens.

Assessment of longitudinal motion and deformation are the most accurate indicators of CAD, especially in patients with coronary stenosis, where sporadic ischemia can be subtle and detected only with this technique.

Multiple quantitative scoring systems are used to define angiographic CAD load.

Angiographic atherosclerosis is commonly quantified using the Gensini score, where a score of zero shows the absence of atherosclerotic disease. The gensini score takes into consideration both the degree and location of arterial constriction [9].

Meterials & Methods:

The study is a prospective one which conducted at Tanta University Hospital included forty consecutive patients.

Inclusion criteria: Patient who has stable angina pectoris:

- Asked for elective diagnostic coronary angiography either due to positive or equivocal stress test or due to symptoms not responding to medical treatment.
- Aged between 18 -80 years-

Exclusion criteria:

- Impaired left ventricle systolic function (EF<45%)-
- LVH.
- Congenital heart disease.
- Dilated cardiomyopathy.
- Hypertrophic cardiomyopathy.
- Restrictive cardiomyopathy.
- Acute coronary syndrome.
- Severe renal impairment.

Statistical analysis

Data were entered into the computer and analyzed using version 20.0 of the IBM SPSS software suite. (Armonk, New York: IBM Corporation) Quantitative and percentage descriptions were provided for qualitative data. The Kolmogorov-Smirnov test was performed to determine the distribution's normality. Range, mean, standard deviation, and median were used to characterize quantitative data. At the 5% significance level, the acquired findings were deemed significant. Student t-test, Mann Whitney test, Pearson's correlation coefficient (r) test, and Receiver operating characteristic (ROC curve) analysis were utilized.

Case No. (1)

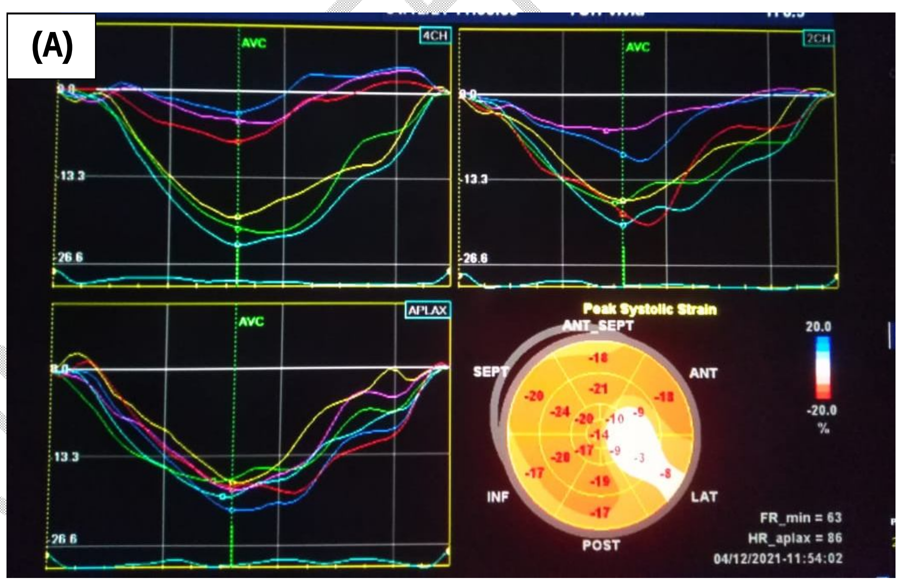
Male patient aged 55 years old known to be diabetic, HTN, dyslipidemia but not smoker, not cardiac before. Patient presented to cardiology department at Tanta university hospital complaining of typical angina chest pain with effort recurrent for 2 months.

Blood pressure: 160\100 mmHg

Heart rate: 100/min.

Respiratory rate: 20/min.

2D speckle tracking echocardiographic analysis was done. Bull's eye appears in the center of the image showing the regional strains with average GLS of – 11.5%. In the image we notice marked impairment in the regional strains of the following myocardial segments (apical, apicoanterior, midanterior, basal anterior, basal anteroseptal, apico inferior, apicolateral and mid anterolateral). Diagnostic coronary angiography was done and revealed osteal significant lesion (75%) in Lt main coronary artery and significant proximal lesion (90%) in LAD, Gensini score was calculated and equals (40) and PCI was done by implantation of 2 DES for Lt main –LAD with good angiographic results.



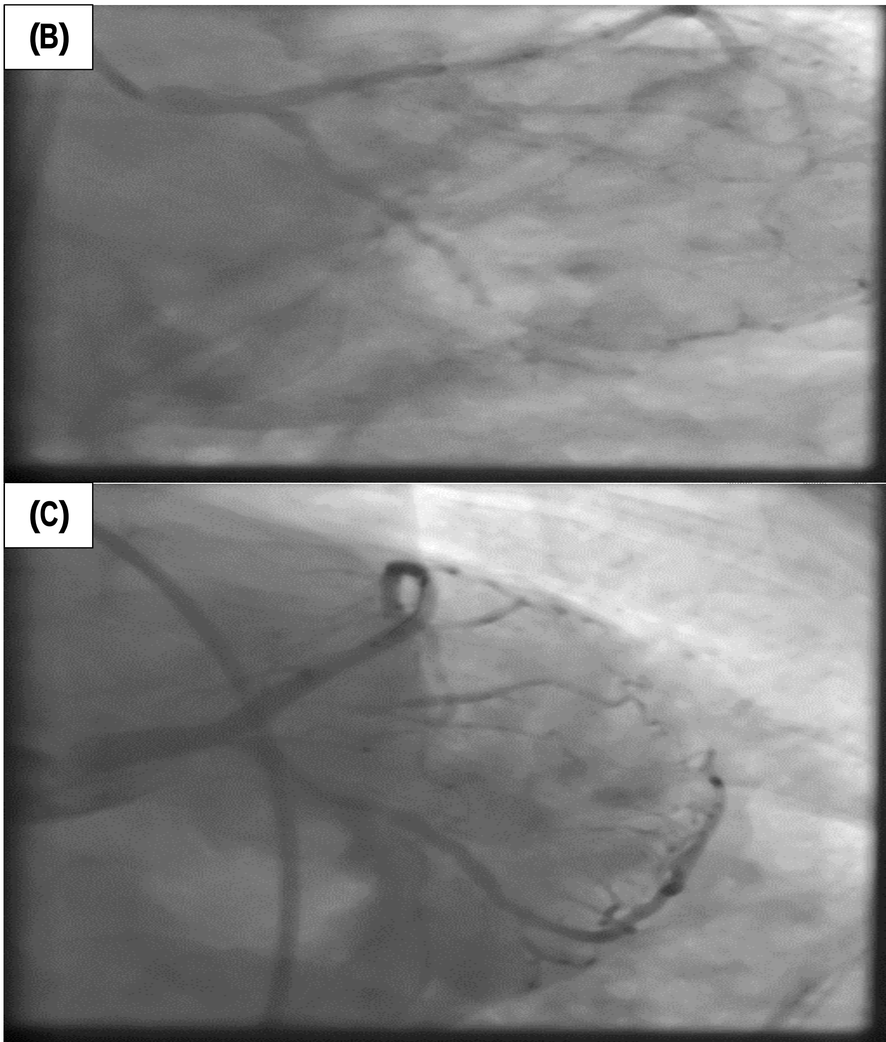


Figure 1: A) Speckle Tracking Echocardiography revealed marked impairment in the regional strains of the following myocardial segments (apical, apicoanterior, midanterior, basal anterior, basal anteroseptal, apico inferior, apicolateral and mid anterolateral). **B)** Diagnostic coronary angiography showing significant Left Main-proximal LAD lesion. **C)** Coronary Angiography after PCI and implantation of DES in Left main- LAD lesion.

Results:

Table 1: Relation between Global Longitudinal Strain (GLS) and risk factors of Stable Angina Pectoris patients in the study

GLS		Range			Mean	±	S. D	t. test	p. value
Sex	Male	21.8-	–	-11	-14.56	±	3.19	0.157	0.876
	Female	19.6-	–	11.1-	-14.73	±	3.10		
DM	No	21.7-	–	12.1-	-17.03	±	3.05	2.871	0.007*
	Yes	21.8-	–	11-	-13.92	±	2.82		
HTN	No	21.8-	–	11-	-13.71	±	2.49	2.387	0.022*
	Yes	21.7-	–	11.2-	15.98-	±	3.54		
Dyslipidemia	No	21.7-	–	11.2-	-13.79	±	3.38	0.967	0.340
	Yes	21.8-	–	11-	14.89-	±	3.04		
Smoking	No	19.6-	–	11.1-	14.92-	±	3.04	0.528	0.601
	Yes	21.8-	–	11-	14.39-	±	3.23		

The study showed insignificant correlation between GLS and sex with Mean of GLS -14.56 in males and -14.73 in females with p value 0.876. The study showed significant correlation between GLS and DM with Mean of GLS -17.03 in non-diabetic patients and- 13.92 in diabetic patients with p value 0.007. The study showed significant correlation between GLS and hypertension with Mean of GLS -13.71 in non-hypertensive patients and -15.92 in hypertensive patients with p value 0.002. The study showed that insignificant correlation between GLS and dyslipidemia with Mean of GLS -14.89 in dyslipidemic patients and -13.79 in non dyslipidemic patients with p value 0.340. The study showed insignificant correlation between GLS and smoking with Mean of GLS -14.39 in smoker patients and -14.92 in non smoker patients with p value 0.601. And so, this research showed significant correlation between GLS and both DM and HTN but there is insignificant correlation between GLS and sex, dyslipidemia and smoking (table 1).

Table 2: Relation between Global Longitudinal Strain (GLS) and Coronary Gensini Score and Age in the study.

	GLS	
	R	p
Gensini score	0.799	0.001*
Age	0.044	0.788

The study showed inverse relation between Global Longitudinal Strain and Gensini Score. The study showed no significant relation between age of the patients and GLS (table 2).

Table 3: Relation between number of coronaries affected and Global longitudinal Strain (GLS) in the study.

		N	**%**	**Mean of GLS**
Number of coronaries affected	**1vessel disease**	4	10	- 13.58
	2vessel disease	29	72.5	- 15.33
	3vessel disease	6	15	- 12.43
	4vessel disease	1	2.5	- 11.30

The study showed that 1 vessel disease was found in 4 patients with percentage 10% and mean of GLS -13.58. The study showed that 2 vessel disease was found in 29 patients with percentage 72.5% and mean of GLS -15.33. The study showed that 3 vessel disease was found in 6 patients with percentage 15 % and mean of GLS -12.43. The study showed that 4 vessel disease was found in 1 patient with percentage 2.5% and mean of GLS -11.30. And so, the lowest GLS was found in 3 and 4 coronary vessel disease than in 1 and 2 coronary vessel disease (table 3).

Table 4: Sensitivity and specificity of Speckle Tracking Echocardiography in detection of LAD, LCX and RCA in lesions severity.

	Cut off	**AUC**	**Sensitivity**	**Specificity**	**PPV**	**NPV**	**Accuracy**
LAD	- 16.5	0.816	90	70	92	64	86
LCX	-17.3	0.648	68	60	74	53	65
RCA	-15.2	0.615	60	67	76	50	63

The study revealed that sensitivity of STE in detection of LAD lesions severity was 90% while specificity of STE in Detection of LAD lesions severity was 70% with PPV(positive predictive value) 92, NPV (negative predictive value) 64 and accuracy 86% with cutoff -16.5 (table 4).

The study revealed that sensitivity of STE in detection of LCX

Lesions severity was 68% while specificity of STE in detection

Of LCX lesions severity was 60% with PPV 74, NPV 53 and accuracy 65 % with cutoff -17.3 (table 4).

The study revealed that sensitivity of STE in detection of RCA lesions severity was 60% while specificity of STE in detection of RCA lesions severity was 67% with PPV 76, NPV 50 and accuracy 63 % with cutoff -15.2. And so, the study revealed that sensitivity of STE in detection of LAD lesions severity was higher than that of LCX and RCA respectively. While specificity of STE in detection of LAD lesions severity was higher than that of RCA and LCX respectively (table 4).

Discussion

Another study showed that with multivariate logistic regression test, it was found that age, diabetes and smoking are significant predictors for low longitudinal strain reduction (LSR). This was concordant with Cognet et al [11], which agrees with the fact that there are age-related effects on cardiac muscle deformation; GLS declines at rest with aging in a healthy individuals, and these observations may be partially explained by the decreased coronary flow reserve associated with age and myocardial ischemia [12]. In addition, diabetes was found to be a predictor of LSR. This also was concordant with Wierzbowska-Drabik et al [13], who found that diabetes is a predictor of LV LSR at rest and at dobutamine stress in cases with significant CAD. This agrees with the fact that diabetes induce complex metabolic disturbances in cardiomyocytes, impairment microcirculation, and endothelial dysfunction leading to morphological and functional abnormalities of the cardiac muscle [14]. Moreover, smoking was found to be a predictor of LSR. This agrees with the fact that smoking has acute and chronic deleterious effect on myocardial function and deformations [15].

According to another study, GLS reserve represents the most sensitive predictor of CAD severity as measured by the Gensini score. In addition, the study discovered a statistically significant inverse link LSR and Gensini score ($r = 0.79$, $P = 0.00$). In furthermore, a multivariate logistic regression analysis revealed that smoking, aging, and DM were strongly predictors of low LSR. Interestingly, it was discovered that LSR at a cut-off value of 2.9% can indicate severe CAD and at a cut-off point of 2.7% can predict LM comparable illness [16, 17].

GLS decreased as the involved coronary arteries number increased in individuals with stable angina, and there was a strong positive correlation between GLS and LVEF ($r = 0.36$; $p = 0.036$); they demonstrated a significantly slightly weaker cut-off point for GLS than other measurements (GLS > 15.6% had AUC 0.88, 95% for the prediction of significant CAD; p

0.001), most likely due to the higher cut-off point of coronary artery stenosis considered to define significant CAD (>70% narrowing) [18].

In another investigation of 211 cases, excluding diabetics, the accuracy of GLS > 19% to identify coronary-specific critical stenosis (stenosis 70% in 1 epicardial coronary artery and 50% in the LCA) was evaluated. The AUC for detecting LCA stenosis was 0.818 for CX, 0.764 for LAD, and 0.773 for RCA. [19].

Conclusion

The study clearly observed the contribution of STE to the assessment of CAD severity in patient with stable angina pectoris. This investigation has paved the path for myocardial strain research in the future, which holds promise as a noninvasive, low-cost diagnostic tool for those with stable angina.

Consent

As per international standard or university standard, patient(s) written consent has been collected and preserved by the author(s).

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