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# Left ventricular longitudinal strain as a predictor of coronary artery involvement instead of coronary angiography in the diagnosis of stenosis

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## Abstract

**Objective:** Evaluate the value and accuracy of longitudinal strain in detection of coronary artery disease compared to coronary angiography.
**Methods:**
It is a prospective study included 200 patients with suspicion of coronary artery disease. LV longitudinal strain and coronary angiography was done.
**Results:**
LV longitudinal strain showed high sensitivity for the diagnosis of single vessel CAD (68%), specificity (79%), two vessels disease (80%, sensitivity 88%) and for three vessels CAD (sensitivity 87% and specificity 90%).
**Conclusion:**
LV longitudinal strain is good noninvasive parameter in the detection of coronary artery stenosis with very good agreement with angiography. It is of value especially with multiple coronary artery stenosis and mainly those with LAD stenosis. It is surrogate in absence of ECG changes or regional wall motion abnormality.

**Keywords:** strain, left ventricular, stenosis, coronary artery

## Introduction

For many years LV longitudinal strain used for evaluation long axis function of LV whenever thereis suspicion of ischemia or subclinical dysfunction (Zito *et al.*, 2018), in heart failure with preserve LV global function, in those with cytotoxic therapy, and in differentiation of different form of LVH (Bshiebish *et al.*, 2019). But it is the cornerstone in the detection of coronary artery disease,it has increasingly apparent value even in low risk for acute coronary syndrome (ACS) even prior or without rise in cardiac biomarkers or ECG changes (Norum *et al.*, 2015, Abdulrazaq *et al.*, 2017).

Up to 40% of patients'with chest pain who have significant coronary artery disease had negative treadmill test ,negative ECG, and negative 2D echocardiography, but positive LV longitudinal strain test (Smiseth *et al.*, 2016).Though LV longitudinal

strain is safe, noninvasive,less time consuming, but still exercise testing is widely used for selecting patients for coronary angiography(Mordi *et al.*, 2017).

The current work aimed to evaluate the value and accuracy of longitudinal strain in detection of coronary artery disease compared to coronary angiography.

## Patients and Methods

### *Study sample*

It is a prospective study included 200 patients with suspicion of coronary artery disease. LV longitudinal strain and coronary angiography was done.

### *Ethical approval*

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee of Ibn Al Bittar cardiac surgical center (Code: 00128) and with the 1964 Helsinki declaration and its later amendments.

### *Informed consent*

Informed written consent was obtained from all individual participants included in the study

### *Study protocol*

All the study subjects were evaluated by treadmill test TMT (which is considered positive TMT if there is ST segment deviation one mm or more in one or more ECG leads and/or if the patient develops ischemic chest pain).

Lipid profile, conventional echocardiography & 2D LV longitudinal strain using speckle tracking analysis by the available 2D strain software (GE Vivid E9) within 10 days prior to scheduled coronary angiography.

### *Conventional echocardiography*

Conventional echocardiography was done using echocardiography machine (GE Vivid E-9) and phased-array probe with a frequency of 2.5-4 MHz

### *Two-dimensional speckle tracking analysis*

Using available 2D strain software (GE E-9), acquisition of 3 (2-chamber, 3-chamber and 4-chamber) was done. All images were digitally stored at a high frame rate (>65 frames/s, mean 70 ±10), software algorithm automatically segmented the LV into six equidistant using AFI.

The global and regional LV longitudinal strain were evaluated in Bull eyes model along with Systolic lengthening and PSS.All measurements were preformed off-line on a dedicated workstation,all segments were computed adequately and (−16%) was considered as impaired GLS.

### *Coronary angiography*

Coronary angiography was done for all patient using standard protocol and the diagnosis of CAD was defined if there is stenosis more than or equal to 50% in left main coronary artery (LMS) and/ or if the stenosis was more than or equal to 70% in the right coronary artery (RCA), left anterior descending coronary artery (LAD) and/or circumflex coronary artery (CX).

### *Statistical analysis*

Data of the patients were entered and analyzed using the statistical package for social sciences (SPSS) version 22, IBM Inc., Chicago, USA. Cross-tabulation and Receiver operating characteristics (ROC) curve analysis was used to assess the validity of the 2D LV Longitudinal strain.

## Results

Table 1: Demographic and clinical characteristics

| Variables | Value |
|---|---|
| Number | 200 |
| Age (years), mean ± SD | 52±8 |
| Gender, n (%) | |
| Male | 156 (78%) |
| Female | 44 (22%) |
| Diabetes | 56(28%) |
| Hypertensive | 74(37%) |
| Hyperlipidemia | 64(32%) |
| Pericardial Fat | 92(46%) |

Table 2: Angiographic and 2D LV Longitudinal strain –speckle tracking in study patients

| Stenosis Coronary artery | Angiographic | | LV strain | |
|---|---|---|---|---|
| | **No** | **%** | **No** | **%** |
| LAD | 178 | 89 | 164 | 82 |
| CX | 152 | 76 | 148 | 74 |
| RCA | 168 | 84 | 160 | 80 |
| CX: circumflex coronary artery, LAD: Left anterior descending, RCA: right coronary artery | | | | |

Table 3: Validity and performance of 2-D LV Longitudinal strain-speckle tracking in detection of different numbers of stenosed coronary arteries

| No of vessels | Longitudinal strain No. (%) | Coronary angiography No. (%) | Sensitivity | Specificity |
|---|---|---|---|---|
| 1 vessel | 30(15%) | 27(18%) | 68% | 79% |
| 2 vessels | 40(20%) | 34(22%) | 80% | 88% |
| 3 vessels | 86(43%) | 70(46%) | 87% | 90% |

Table 4: Validation of LV longitudinal strain and coronary angiography in the detection of CAD

| | Sensitivity | Specificity | accuracy |
|---|---|---|---|
| RCA | 93% | 70.4% | 90.2% |
| CX | 92.9% | 81.3% | 90.3% |
| LAD | 90% | 93.6% | 97.8% |

Table 5: Validation of LV longitudinal strain and coronary angiography in the detection of coronary artery stenosis

| | Sensitivity | Specificity | Accuracy |
|---|---|---|---|
| CX | 88% | 78% | 89.5% |
| RCA | 89% | 82% | 87% |
| LAD | 90.1% | 97% | 96% |

## Discussion

Speckle tracking echocardiography (STE) is a new non-invasive technique for documentation of myocardial function(Diamond and Forrester, 1972). LV longitudinal strain is of value in the detection of ischemia even prior to ECG changes and even prior to regional wall motion abnormality by 2D echo (Esmaeilzadeh *et al.*, 2013), regional wall motion abnormality is semi-quantative way of detection of ischemia, also (STE) of value in hypertensive patient in the detection of ischemia when reginalwall motion abnormality masked by LVH(Youssef *et al.*, 2018).
LV longitudinal strain showed a high sensitivity and specificity for the diagnosis of single vessel CAD (68%, and 79%, respectively), two vessels disease (80%, and 88%, respectively) and for three vessels CAD (87%, and 90%, respectively), which similar to other studies (Moustafa *et al.*, 2018).

This is not consistent with the study that mentioned by Aggeli et al where the main percentage was found in one vessel (46%), 14% in two vessels and 7% in three vessels(Aggeli *et al.*, 2015).

According to the angiographic findings, it was found that left anterior descending coronary artery (LAD) stenosis was reported in (82%), the left circumflex coronary artery (LCX) stenosis reported in (74%) and the right coronary artery (RCA) stenosis was found in (80%) of the patients while in a study done in USA by Montgomery et al the results were: the stenosis in LAD only (21%), in LCX only (9%) and the stenosis in RCA only (7%) (Montgomery *et al.*, 2012). While in Moustafa et al (61.7%) had LAD, (43%) had LCX, and (40.5%) had the RCA disease (Moustafa *et al.*, 2018).

The longitudinal strain showed that there was a good performance in detection of stenosis in LAD with high sensitivity, specificity and accuracy(90.1%, 97%, and 96%; respectively). Regarding stenosis of RCA, 2-D LV longitudinal strain had a sensitivity of (89%), specificity of (82%) and accuracy of (87%). While CX artery stenosis (sensitivity 88%, specificity 78%, and accuracy 89.5%) .Additionally, this study showed the validity of longitudinal strain in thedetection of stenosis in different number of coronary arteries, hence, the validity and performance in detection of 3 vessels stenosis was good with (87% sensitivity, and 90% specificity). InAggeli et al reported that the sensitivity for detection of coronary artery disease was 38%, 29% and 28% in LAD, LCX and RCA respectively (Aggeli *et al.*, 2015).

The average value of global longitudinal strain (GLS) in this study was (–17 ± 0.1%) for normal GLS, and any value assessed by AFI less than (−16%) was considered as impaired GLS, while the normal GLS was (-14 ± 3.3%) in Cimino et al study (Cimino *et al.*, 2013).

## Conclusion

LV longitudinal strain is good noninvasive parameter in the detection of coronary artery stenosis with very good agreement with angiography. It is of value especially with multiple coronary artery stenosis and mainly those with LAD stenosis. It is surrogate in absence of ECG changes or regional wall motion abnormality.

## Conflict of Interest statement

None

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