



# The Value of 2D Global Longitudinal Strain in Predicting the Severity of Coronary Artery Disease in Patients with NSTEMI and Unstable Angina and Regional Strain Value for Predicting the Culprit Artery

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. Author KH contributed to study conception and design. Authors KH and EA a contributed to data acquisition, data analysis, interpretation, writing of article. Author HM help control the interpretation of echocardiography loops. Author HR and AD reviewing and final approval of article. All authors read and approved the final manuscript.*

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## ABSTRACT

**Background:** Our study aimed to evaluate the predictive ability of resting strain to determine the severity of CAD in the absence of impaired LVEF in patients with NSTEMI and unstable angina. Additionally, the study sought to predict culprit and infarcted related artery (IRA) using regional strain (SLR).

**Methods:** The study was conducted between January 2023 and May 2023 at the cardiology department of Ibn Rochd Hospital, Morocco. We conducted a comparative analysis involving 30 patients, comprising 23 individuals with NSTEMI and 7 with unstable angina. In all cases, we assessed both GLS and RLS before proceeding to coronary angiography. Subsequently, we categorized the patients into two groups: one consisted of 18 individuals with severe coronary lesions, including left main trunk (LM) and three vessels lesions, while the other group, comprising 12 patients, served as the control group and had non-severe coronary lesions

**Results:** At resting GLS threshold below -16,3 %, despite its subnormal nature, should raise suspicion and suggest severe coronary artery disease. RLS in the "Single-vessel" group was significantly lower in the culprit artery territories, suggesting that RLS may be a better marker for identifying the culprit artery. Both GLS and the visual analysis of segmental kinetics by WMSI (Wall Motion Score Index) at rest, were statistically significant for detecting severe coronary lesions.

**Conclusion:** GLR and SLR are sensitive markers for early detection of myocardial ischemia and predicting its severity. A resting GLR threshold of less than -16.13% could indicate severe CAD with severe tri-truncular or LMT damage, especially when combined with abnormal WMSI scores. These 2D strain parameter changes precede subjective abnormalities in segmental kinetics, which are often considered normal at rest.

*Keywords: Coronary artery disease; diabetes mellitus; Global Longitudinal Strain; speckle tracking.*

## 1. INTRODUCTION

The aim of this study is to assess the effectiveness of globale 2D strain imaging in detecting and quantifying myocardial ischemia at rest, specifically to differentiate severe coronary artery disease (CAD) of the tri vessels and left main CAD (LMT) type from non-severe mono- or bi-vessel disease in patients with NSTEMI and unstable angina [1,2]. Traditionally, the non-invasive echocardiographic detection of myocardial ischemia in CAD, especially severe disease, requires a stress test because abnormalities in segmental kinetics are often not present at rest [3,4,5,6-8]. However, recent studies have shown that 2D strain imaging has good sensitivity in detecting CAD at rest, even in cases where segmental kinetics are normal and left ventricular ejection fraction (LVEF) is within the normal range at baseline.

## 2. MATERIALS AND METHODS

### 2.1 Aim of the Study

Our aim in this study was to evaluate the ability of resting 2D global strain to predict the severity of Coronary artery disease (CAD) in patients with NSTEMI and unstable angina by distinguish the sever lesions define by tree vessel lesions

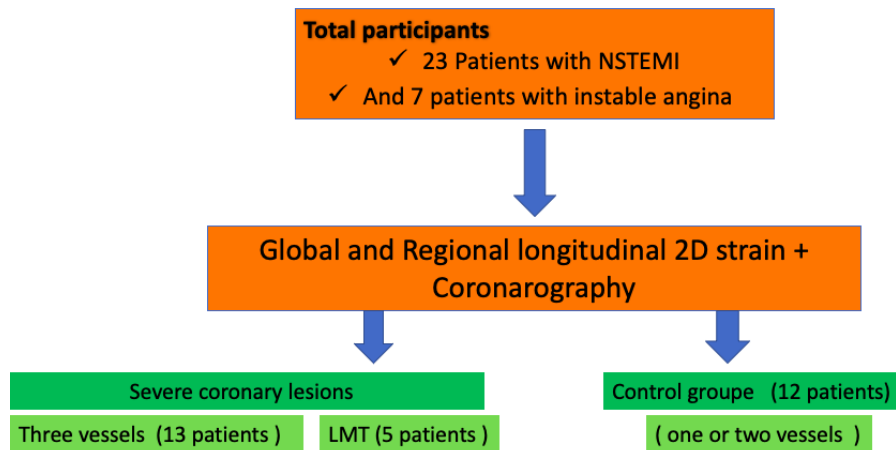
and left main lesions from one or two vessel CAD involvement. Also, to predict the infarcted related artery (IRA) by regional strain (SLR).

### 1.2 Study Population

We conducted a prospective, longitudinal, evaluative study between January 2023 and May 2023 in the cardiology department of IBN ROCHD UNIVERSITY HOSPITAL OF CASABLANCA- MOROCCO. In this study, we compared data of 30 patients, including 23 patients with NSTEMI and 7 patients with unstable angina.

We conducted a comparative analysis involving 30 patients, comprising 23 individuals with NSTEMI and 7 with unstable angina. In all cases, we assessed both GLS and RLS before proceeding to coronary angiography. Subsequently, we categorized the patients into two groups (Fig. 1).

- One consisted of 18 individuals with severe coronary lesions, including 5 patients with left main lesions (defined on coronary angiography by a significant lesion  $\geq 50\%$  of the left main coronary artery); and 13 patients with three vessel lesions (defined on coronary angiography by a significant lesion  $\geq 70\%$ ).



**Fig. 1. The study conception and design**

- While the other group, comprising 12 patients, served as the control group and had non-severe coronary lesions defined by one and two vessel CAD.

The study participants were predominantly male, with a rate of 67.9% (n/N=19/30), compared with 28% (n/N=11/30) who were female. The average age of the participants was 62 years, with extremes ranging from 81 years to 60 years.

The exclusion criteria were simple and included: Unstable angina, Non-ST elevation myocardial infarction (NSTEMI), Preserved LVEF while the exclusion criteria included Significant intercurrent pathologies that could potentially affect the strain study, such as: (1) History of myocardial infarction (MI) and/or Percutaneous Coronary Intervention (PCI) or Coronary Artery Bypass Grafting (CABG), ST elevation coronary syndrome (STEMI) or post-MI, and chronic coronary syndrome. (2) left ventricular ejection fraction (LVEF) below 50%. (3) Individuals with congestive heart failure and haemodynamic instability. (4) significant mitral or aortic valve disease, arrhythmia, hypertrophic cardiomyopathy (septal, wide QRS  $\geq$  120 ms, or pericardial involvement. (5) Patients whose echocardiographic images were not suitable for the evaluation of 2D strain parameters were excluded from the study. (6) The "control" group excluded individuals with a combination of significant stenoses of the proximal left anterior descending artery (LAD) and proximal circumflex artery (CX) to avoid potential confusion at the pathophysiological level with those of the three vessels and left main CAD

### 2.3 Echocardiography

On admission, a transthoracic echocardiography (TTE) was performed using a General Electric ViVid S70N machine. The TTE utilized a 2.5-5 MHz transducer and an M5s matrix probe while simultaneously recording the electrocardiogram. The imaging was conducted in apical views (including 4, 2, and 3 cavity slices) using two-dimensional loops. In addition to the standard echocardiography assessment, segmental parietal kinetics were evaluated based on the recommended segmentation of 17 segments established by the latest guidelines from American and European cardiology societies [9]. The wall motion score index (WMSI) was calculated by summing the individual WMSi values of each of the 17 segments analyzed and dividing by the total number of segments (17). The regional wall motion score index in the territories of the three main epicardial coronary arteries was calculated based on the allocation of segments to the corresponding coronary artery distributions [10].

### 2.4 Coronary Angiography (CA)

Coronary Angiography (CA) was performed by the percutaneous femoral and radial approach. CA were obtained for each coronary vessel in 2 projections, and stenosis with 70% reduction in the lumen of the epicardial arteries and 50% for the LM trunk, was considered significant. The interpretation of the angiograms loops was performed visually by an experienced coronarographiste.

## 2.5 Statistical Analysis

All analyses were made using the “SPSS 17 for Mac” soft- ware package. Continuous variables were expressed as mean ± standard deviation; categorical variables were expressed as percentages. Independent T-test was used to compare means, ANOVA to compare multiple groups. Chi-square test was used to compare percentages. Pearson’s correlation coefficients were used to assess the strength of relationship between continuous variables. ROC curve was plotted to get cutoff value, sensitivity and specificity. We used multiple linear regression analysis, A p value of less than 0.05 was considered significant.

## 3. RESULTS

Of the 30 patients participating in the study, 13 patients (or 43% of participants) had three

vessel CAD and 5 patients (or 17%) had Left main CAD. In the "control" group 8 patients (or 13%of the participants) had one vessel CAD lesions and 27% (or 4 patients) had two vessel CAD lesions (Table 1). The two groups had similar age distributions. However, there was a male predominance in the group with severe lesions, specifically in cases involving left main CAD and three-vessel CAD, as shown in Table 1. Concern comorbidities, the severe lesions group exhibited a higher prevalence of comorbid conditions, with diabetes being particularly prominent. We categorized these patients as fertility patients (Table 1).

The analysis of 2D strain echocardiography data revealed a significantly lower Global Longitudinal Strain (GLS) in both the subgroups "three vessels, LM CAD" groups (15.9% and 16.63% respectively) compared to the control group "one and two vessel CAD " (24.3% and -22%

**Table 1. Overview of general characteristics of the study population**

|                          | Severe CAD   |      | Groupe contrôle |            |
|--------------------------|--------------|------|-----------------|------------|
|                          | Three vessel | LM   | Two vessel      | One vessel |
| Participants (n/N)       | 13/30        | 5/30 | 4/30            | 8/30       |
| NSTEMI                   | 10           | 5    | 3               | 5          |
| Instable angina          | 3            | 0    | 1               | 3          |
| Sexratio (M/F)           | 8/5          | 5/0  | 1/3             | 5/3        |
| Average Age (year)       | 61.3         | 63.2 | 62              | 60         |
| Diabete                  | 6            | 2    | 0               | 2          |
| Hypertension             | 8            | 4    | 3               | 6          |
| Tabac                    | 2            | 3    | 1               | 2          |
| Dyslipidemie             | 2            | 3    | 1               | 2          |
| History of stable angina | 2            | 1    | 2               | 2          |

**Table 2. Resultats of Global longitudanal strain and angiographic resultats**

|                    | Severe CAD    |          | Groupe contrôle |            |
|--------------------|---------------|----------|-----------------|------------|
|                    | Three vessels | LM       | Two vessels     | One vessel |
| Participants (n/N) | 13/30         | 5/30     | 4/30            | 8/30       |
| NSTEMI             | 10            | 5        | 3               | 5          |
| Instable angina    | 3             | 0        | 1               | 3          |
| GLS** AVERAGE (%)  | -15.9         | -16.63 % | -22             | -24.3      |
| WMSI£ global n/N   | 6/17          | 7.7/17   | 4/17            | 2/17       |
| RLS* LAD§ (%)      | -14.6         | -14.1    | -27.5           | -25        |
| WMSI LAD n/N       | 2.6/7         | 3.2/7    | 1.5/7           | 0.4/7      |
| RLS CX\$ (%)       | -14.8         | -15.32   | -20             | -28.5      |
| WMSI CX (n/N)      | 2.3/5         | 2.4/5    | 0.75/5          | 0.2        |
| RLS RCA § (%)      | -18.7         | -22      | -21             | -27        |
| WMSI RCA (n/N)     | 1/5           | 1/5      | 2.5/5           | 1.2/5      |

\*\* : global longitudinal strain , \* : regional longitudinal strain  
 § : left anterior descending coronary artery, \$ : Right coronary artery  
 § : Circonflex artery  
 £ : Wall Motion Score Index

respectively). The reduction in GLS in the subgroup of three vessels lesions correlated with a decrease in Segmental Longitudinal Radial (SLR) strain in the territories of LAD, CX, and RCA. However, in the "LM stenosis" group, SLR was lower only in LAD and CX territories (Table 2).

Multivariate logistic regression analysis found that the most predictive parameter for severity of CAD is GLS cutoff  $-16.13\%$ . SLR in the "one vessel" subgroup was significantly lower in the territories of the culprit arteries, suggesting it may be a better marker for determining the culprit artery. Global Longitudinal Strain (GLS) and visual analysis along with semi-quantitative analysis of segmental kinetics using the Wall Motion Score Index (WMSI) at rest were all statistically significant for detecting severe coronary lesions, with GLS showing superiority.

#### 4. DISCUSSION

Echocardiography is absolutely essential in assessing the cardiovascular function and mechanics [10]. Recently, a major breakthrough has been made with the implementation of two-dimensional speckle tracking echocardiography (2D-STE) [10]. Compared to visual wall motion analysis alone, the assessment of 2D global strain (GLS) via speckle-tracking echocardiography during rest can effectively increase detection of severe coronary artery disease (CAD). When looking for severe CAD, it is most effective to combine both GLS and SLR strain.

Our findings indicate that those with triple vessel CAD and left main CAD had lower GLS and SLR strain than those with less severe CAD. If GLS measures below  $-16.3$ , it may indicate the presence of severe CAD despite its abnormality. Detecting severe CAD is demonstrated by this outstanding threshold providing specificity above 90% and sensitivity around 60%. In conjunction with other studies, our findings validate GLS imaging's potential in gauging CAD severity [11,12]. In the meta-analysis conducted by Norum and their team, as well as Keven Lior and their team, the potential of 2D strain was confirmed. They examined 1385 patients in 10 separate studies and found that resting strain serves as an early indication of myocardial ischemia and can predict moderate to severe coronary lesions in symptomatic individuals. Our cutoff for GLS at rest ( $-16.3\%$ ) aligns with the figures documented in this meta-analysis.

By adhering to the guidelines set forth by the American and European cardiology societies, 17 artery segments were carefully analyzed to determine their respective territories and calculate the regional strain (SLR). The effectiveness of this method has been repeatedly proven in various studies, which also endorse implementing SLR measurement to pinpoint the infarct-related artery (IRA) through an examination of SLR throughout all epicardial artery territories and identifying any deviations.

#### 5. CONCLUSION

GLS and RLS are sensitive markers for early prediction of myocardial ischemia and its severity. A GLS threshold of less than  $-16.13\%$  at rest, despite its subnormal nature, should be alerting and raise suspicion of coronary artery disease with severe three vessels or LMT lesions, especially if there are concomitant abnormalities in the WMSI score. This alteration in global longitudinal 2D strain precedes the subjective abnormalities in segmental wall motion, which were often considered normal at rest.

#### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

#### ETHICAL APPROVAL AND CONSENT

An informed written consent was obtained from each patient according to the declaration of Helsinki and the rules of the Local Ethics Committee of Faculty of Medicine, Hassan II University, Morocco.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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## APPENDICES

### Fiche d'exploitation

- Age (ans) :                      Sexe :                      Tel :
- Nom :
- FRCVx :
  - Diabète                      HTA                      Dyslipidémie
  - Tabac                      Héritéité                      Antécédent d'angor stable
  - Antécédent d'IRC
- La présentation clinique
  - Angor stable
  - Angor instable
  - NSTEMI
- Echocardiographie :
  - LA FEVG :%
  - LES PRVG
  - LA PAPS
  - SLG :
  - SLR : IVA              Cx              CD
  - Wall Motion Score Index global et régional dans les territoires de  
WMSI : WMSI IVA                      WMSI CX                      WMSI CD
- Données agiographiques :
  - TCG : Proximal :              Corps                      Distal
  - Atteinte diffuse : IVA              CX                      CD                      autre :
  - Statut coronarien :
    - Monotronculaire
    - Bitrinsulaire
    - TriTronculaire

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