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Original Article

The correlation between global longitudinal strain by speckle tracking echocardiography and coronary angiogram finding in patients with suspected chronic stable angina pectoris

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Abstract

The objective of this study was to evaluate and forecast the significance of Global Longitudinal Strain (GLS) measured at rest and its correlation with the presence and severity of coronary artery disease (CAD) in individuals with suspected stable angina pectoris in the Sri Lankan population

Patients diagnosed with chronic stable angina and normal left ventricular function (EF ≥ 50%) were included in the study and underwent coronary angiography, followed by speckle-tracking echocardiography. The study measured the global longitudinal strain and analyzed its correlation with the coronary angiography findings for each patient.

A total of 78 participants were included in this study, 44(56.5%) were diagnosed with coronary artery disease. Significant differences between CAD and non-CAD groups were observed in terms of age (P - 0.003), diabetes mellitus (P - 0.02), hypertension (P - 0.004) and family history of premature CAD (P - 0.01). There was a notable decrease in GLS values among CAD patients (-17.97 ±0.85) compared to non-CAD patients (-20.26 ±1.03), with a significant decrease observed as the count of affected vessels rose (P = 0.0001). A GLS cutoff value of -19 demonstrated promising sensitivity (72.7%) and specificity (70.6%) in predicting significant CAD, supported by an AUC of 0.717 (P = 0.001). In regression analysis, only diabetes showed a significant association with reduced GLS. GLS demonstrated a significant p-value of less than 0.001 (β -2.292 CI [-3.6594, -0.9246]) establishing it as an independent and significant predictor of the presence of significant coronary artery disease.

Assessing global longitudinal strain at rest demonstrates excellent diagnostic accuracy for detecting coronary artery disease in patients with chronic stable angina and normal systolic function.

Keywords

Chronic stable angina, Echocardiography, Kandy Sri Lanka

Introduction

Coronary artery disease (CAD) is a significant cardiac issue in the world that contributes to high morbidity and mortality. A common initial presentation of coronary artery disease (CAD) is chronic stable angina (CSA) which is approximately 50% of cardiovascular disease patients [1].

Non-invasive investigations such as functional imaging to detect ischemia or anatomical imaging via CT coronary angiography (CTCA) are recommended as the primary diagnostic approaches for stable coronary artery disease [2]. CTCA, myocardial perfusion imaging or stress magnetic resonance imaging are giving high diagnostic accuracy. However, the major limitations are lesser availability, exposure to radiation, and additional expense. Exercise electrocardiography, while cost-effective, demonstrates lower diagnostic accuracy compared to imaging tests and has restricted capability to rule in or rule out coronary artery disease [2]. Dobutamine stress echocardiography is another noninvasive investigation with relatively inexpensive and free of radiation exposure, but it requires expertise and has infrequent arrhythmogenic complications [3].

Speckle Tracking Echocardiography is an ultrasound imaging technique utilized to identify cardiac tissue

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motion by analyzing speckle patterns within the heart muscles. Specifically, it focuses on detecting the motion of longitudinally oriented myocardial fibers, primarily situated in the subendocardial region. This technique proves valuable in identifying areas prone to ischemia, where intermittent ischemic events can lead to myocardial stunning. Strain measurement via speckle tracking enables the detection of such myocardial abnormalities [4-6]. Longitudinal motion and deformation measurements particularly left ventricular global longitudinal strain (GLS) obtained via two-dimensional speckle-tracking echocardiography, have emerged as highly sensitive indicators for detecting CAD. This technique has shown efficacy in predicting significant CAD in acute or sub-acute ischemic events. [7-9]

The objective of this study was to evaluate and forecast the significance of GLS measured at rest and its correlation with the presence, and severity of CAD in individuals with suspected stable angina pectoris and normal left ventricular function in the Sri Lankan population.

Materials and methods

Study design and study population

This prospective observational study was conducted at National Hospital Kandy between September 2020 and February 2021. The study included patients diagnosed with chronic stable angina who had normal left ventricular function (ejection fraction ≥ 50%). Approval for the study was obtained from the institutional ethics committee (NHK/ERC/28/2020) and informed consent was obtained from all participants. Patients meeting the inclusion and exclusion criteria were selected for the study after the purpose of the research was explained to them, and their informed consent was obtained. The study's stream chart is delineated in Figure 1.

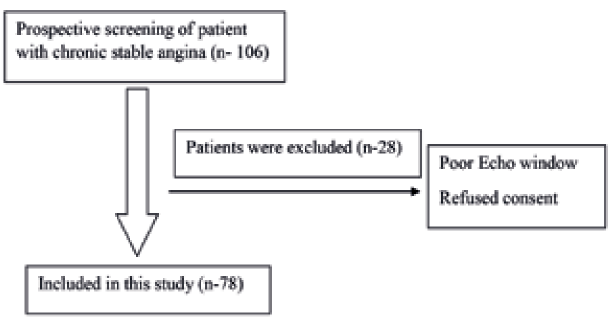

Figure 1: The study's flow chart

Inclusion criteria was patients aged 18 years and above, presenting with symptoms and medical history indicative of suspected stable angina and possessing normal left ventricular function (≥ 50%), were included in the study.

Exclusion criteria was patients with left ventricular systolic dysfunction (ejection fraction < 50%), patients with acute coronary syndrome, a prior history of CABG or myocardial infarction, ECG shows left bundle-branch block or any territory pathological Qwaves or atrial fibrillation, any valvular disease, congestive heart failure, individuals with poor acoustic window, and those undergoing cytotoxic drug therapy.

Each patient underwent a comprehensive clinical examination, including a detailed evaluation of clinical symptoms, risk factors, past medical history, physical examination, and assessment of cardiovascular disease. The findings were documented in a pre-designed data collection form. Moreover, all patient-related information was treated with utmost confidentiality.

Echocardiographic assessment

Standard echocardiographic examination was performed within 24 hours of admission using the Philips® cardiovascular ultrasound system, and the EPIQ 7® scanner. Apical four-chamber, three-chamber and two-chamber views were recorded for three consecutive heart cycles image loops and stored digitally for offline analysis by Q lab software. The left ventricular ejection fraction was assessed by the biplane a2DQ method.

The investigator performed a two-dimensional speckle tracking analysis using software (EPiq 7 c, aCMQ, version 1.5.8). The average of all segmental peak systolic strain values was calculated as GLS.

All offline image loops were analyzed by an investigator blinded to clinical data and before coronary angiography. GLS was assessed using aCMQ strain analysis, involving semi-automatic tracking of acoustic markers frame-by-frame throughout the cardiac cycle. Endocardial borders were delineated at end-systole in 2D images, and longitudinal strains for all myocardial layers were derived from three apical views. Any poorly tracked segments were manually adjusted by the investigator. Segments that remained sub-optimally tracked after manual correction were excluded from the analysis.

Coronary angiography

A coronary angiogram was performed by SEIMONS AXIOM Sensis XP - Digital Cardio Imaging system. Experienced interventional cardiologists who were blinded to patients' data were assessed the coronary angiograms. Significant lesions of the major coronary arteries were inspected in two orthogonal planes. If patients have ≥70% stenosis in the left anterior descending artery, left circumflex artery and right coronary artery with its major branches and ≥50% stenosis in the left main stem would be considered as positive CAD.

Statistical analysis

Statistical analyses were conducted using the SPSS version 17. Quantitative variables were reported as mean ± standard deviation, while qualitative variables were presented as numbers and percentages. The independent sample t-test was used to compare values between two groups for continuous variables, and the chi-square test was employed for categorical variables. Receiver operating characteristic (ROC) curves were used to evaluate the predictive diagnostic value of GLS for the presence of coronary artery disease. Regression analysis was utilized to predict various risk factors associated with coronary artery disease. A P value < 0.05 was considered statistically significant.

Result

A total of 78 participants were included in this study, 44(56.5%) were diagnosed with coronary artery disease (CAD), with those affected being older (60.54 ±2.48) compared to those without CAD (58.67 ±2.9). Among CAD patients, 25(56.8%) had single-vessel disease (SVD), 12 (27.3%) had double-vessel disease (DVD), and 7 (15.9%) had Multi-vessel disease (MVD). Notably, the male-to-female ratio among CAD patients was 2.4:1. Significant differences between CAD and non-CAD groups were observed in terms of age (P - 0.003), diabetes mellitus (P - 0.02), hypertension (P - 0.004) and family history of premature CAD (P - 0.01), while other baseline variables were evenly distributed between the two groups. Details of the baseline variables are provided in Table 1.

Table 1: Details of the baseline variables

Variables	CAD absent (N = 34)	CAD Present (N = 44)	*P* value
Age group	58.67 ±2.91	60.54 ±2.48	0.0032
Male	15 (44.1%)	31 (70.5%)	0.0190
Diabetes mellitus	6 (17.6%)	18 (40.9%)	0.0272
Hypertension	13 (38.2%)	23 (52.2%)	0.0043
Dyslipidemia	7 (20.5%)	13 (29.5%)	0.3689
Family history	2 (6%)	12 (27.2%)	0 .0146
Smoking	4 (11.7%)	7 (15.9%)	0.6020
Ejection fraction	60.38 ±1.6	59.95 ±1.12	0.167

Table 2 presents the mean GLS in both CAD and non-CAD groups, There was a notable decrease in GLS values among CAD patients compared to non-CAD patients (P = 0.0001), with a significant decrease observed as the count of affected vessels rose. Furthermore, figure 1 presents the ROC curve depicting the relationship between GLS values and the severity of coronary artery disease. .A GLS cutoff value of -19 demonstrated promising sensitivity (72.7%) and specificity (70.6%) in predicting significant CAD, supported by an AUC of 0.717 (P = 0.001) and cutoff value of -18 shows sensitivity of 56.8%) and specificity of 79.4% in predicting significant CAD (AUC of 0.681).

Table 2: The mean global longitudinal strain (GLS) value varies depending on the number of vessels blocked in patients.

	CAD absent	CAD present	*P* value
GLS mean	-20.26 ±1.03	-17.97 ±0.85	0.0001
Single vessel disease GLS	-20.26 ±1.03	-18.63 ±1.195	0.0001
Double vessel disease GLS	-20.26 ±1.03	-17.75 ±1.32	0.0001
Multi-vessel disease GLS	-20.26 ±1.03	-15.98 ±1.51	0.0001

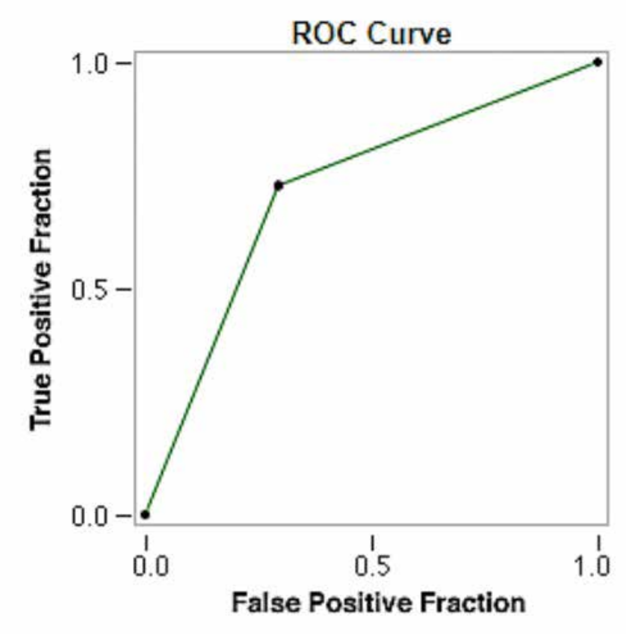

Figure 1: ROC curve depicting the GLS values to predict the significant CAD

In regression analysis, only diabetes showed a significant association with reduced GLS. Other risk factors, significantly difference in two groups such as age, hypertension, and family history of CAD did not predict abnormal GLS. GLS demonstrated a significant p-value of less than 0.001 (β -2.292 CI [-3.6594, -0.9246]) establishing it as an independent and significant predictor of the presence of significant coronary artery disease. (See Table 3)

Table 4: Regression analysis for prediction of CAD

	Standardized coefficients (β)	*P* value	95.0% CI for β Lower	Upper
Age	0 .096	0.832	-0.810	1.002
Diabetes Mellitus	0.13	0.001	0.098	0.153
Hypertension	0.011	0.682	-0.042	0.064
Family history	0.022	0.069	0.349	0.025
GLS	-2.29	.001	-3.659	-0.924

Discussion

This study aimed to assess the predictive value of GLS measured by speckle tracking echocardiography in determining the presence and severity of CAD among stable coronary angina patients. Results revealed a negative correlation between GLS values and the severity of CAD, indicating that lower GLS values were associated with more severe CAD.

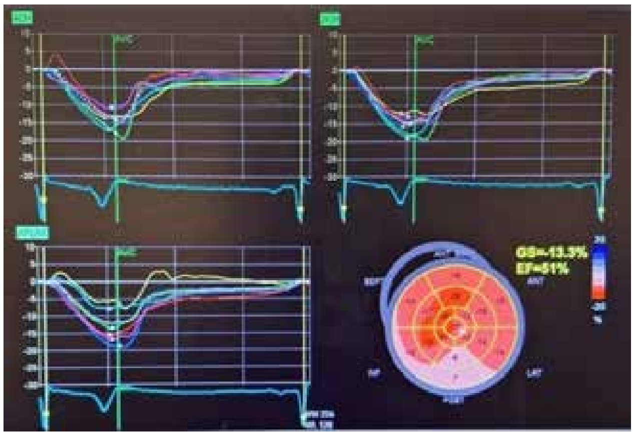

Figure 2

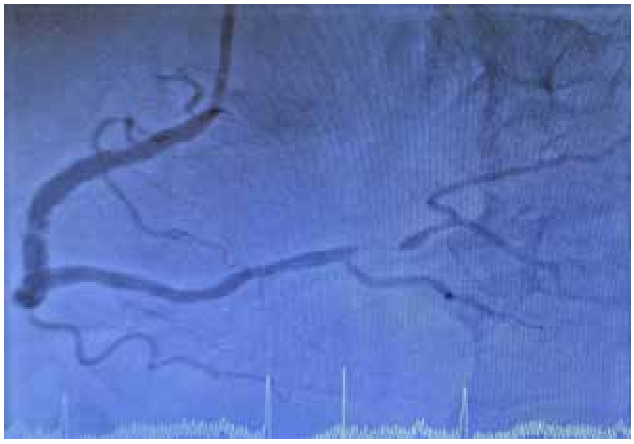

Figure 3

Figure 2 displays the echocardiographic image illustrating GLS, while Figure 3 depicts the coronary angiography of the same patient.

In our study, the mean age group observed was 59.73 ±1.9years, comparable to the population mean age of 60 ± 12 documented by Montgomery et al [10]. We noted a significantly higher prevalence of diabetes mellitus, advanced age, hypertension, smoking, and male gender among patients in the CAD group compared to those in the non-CAD group, consistent with findings reported in previous studies [10-11].

A significant difference ($P < 0.0001$) in GLS was observed between Non-CAD (-20.26 ±1.03) and CAD (-17.97 ±0.85) groups, aligning closely with findings reported by Montgomery et al. [10] and Bakhoum et al. [12].

In our study, we observed a mean GLS value of -18.63 ±1.195 in patients with single-vessel disease (SVD), -17.7 ±1.32 in patients with double vessel disease

(DVD), and -15.98 ±1.51 in patients with multi-vessel disease. These findings align with previous studies by Yadav et al. [13] as well as Radwan et al. [14].. These consistent trends support an inverse relationship between GLS values and the severity of coronary artery disease in our study.

In our study, we determined the optimal cutoff for global longitudinal strain (GLS) in identifying CAD to be -19 (Sensitivity- 72.7%, Specificity- 70.6%, AUC of 0.717 and $P < 0.001$). Furthermore, we observed a decrease in GLS values with increasing severity of CAD, consistent with previous research on longitudinal strain in patients with CSA. Although the optimal diagnostic cutoff for abnormal GLS may vary across studies, our findings align with existing literature. For instance, Liou et al[15]. conducted a meta-analysis involving 10 studies with 1385 patients, reporting pooled sensitivity, specificity, of 74.4% and 72.1% for GLS accuracy in detecting moderate-to-severe CAD.

In our regression analysis, only diabetes showed a significant association with reduced GLS. Notably, other risk factors such as age, hypertension and family history did not emerge as predictors of abnormal GLS, aligning closely with findings reported by Bala et al [11].

The limitations of our study must be acknowledged, including the relatively small and non-randomized patient sample. We solely relied on coronary angiography for comparing GLS values with the presence and severity of disease. Additionally, our study utilized a single type of echocardiography equipment (EPiq 7 c, aCMQ, version 1.5.8), which may introduce variability in GLS measurements influenced by factors such as software type, left ventricular mass and hemodynamic variables. These factors might potentially confound our results. Moreover, we did not assess radial, transverse, circumferential strain, or synchrony analysis, which could provide further insights into myocardial function. Finally, the findings of the coronary angiogram rely on the visual assessment rather than the invasive fractional flow reserve on coronary angiography.

Conclusion

Incorporating GLS measurements from echocardiography may improve the prediction of severe CAD in patients suspected of having it, potentially reducing the need for invasive procedures. However, further validation in larger studies is necessary. Additionally, GLS assessment at rest shows promising diagnostic accuracy for CAD in patients with CSA and normal systolic function, but more research is needed to determine if longitudinal strain analysis alone is sufficient for diagnosing ischemia in CSA patients.

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