ORIGINAL ARTICLE

RESTING GLOBAL LONGITUDINAL STRAIN AS A NONINVASIVE DIAGNOSTIC TOOL IN PREDICTING SIGNIFICANT CORONARY ARTERY DISEASE IN PATIENTS WITH NON-ST-ELEVATION MI AND NORMAL LEFT VENTRICULAR SYSTOLIC FUNCTION ON ECHOCARDIOGRAPHY

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Objectives: This study aimed to assess the relationship between resting global longitudinal strain (GLS) and significant coronary artery disease (CAD) in patients with Non-ST Elevation Myocardial Infarction (NSTEMI) and normal ejection fraction (EF).

Methodology: We enrolled 108 patients with NSTEMI and normal EF in this observational cross-sectional study. Resting GLS was measured, and coronary angiography was performed to assess CAD. The relationship between significant CAD and GLS was analyzed using the chi-square test. The specificity, sensitivity, positive predictive value, negative predictive value, and accuracy of GLS in predicting CAD were calculated.

Results: The mean age of the patients was 49.05 ± 7.28 years. The study had a male predominance. Diabetes was present in 30 patients (27.8%), hypertension in 31 patients (28.7%), dyslipidemia in 19 patients (17.6%), and 65 patients (60.2%) were smokers. Normal strain was observed in 36 patients (33.3%), while 72 patients (66.7%) had reduced strain. Significant CAD was present in 72 patients (66.7%). The p-value for the association between significant CAD and reduced GLS was <0.01. The sensitivity, specificity, and accuracy of GLS in predicting CAD were 91.7%, 83.3%, and 88.9%, respectively.

Conclusion: GLS can effectively predict the presence of significant CAD in patients with NSTEMI and normal left ventricular systolic function on echocardiography.

Keywords: Resting global longitudinal strain, ejection fraction, NSTEMI, coronary artery disease

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INTRODUCTION

Coronary artery disease (CAD) accounts for more than 17 million deaths worldwide, a figure projected to reach 23.6 million by 2030.[1] The incidence of CAD is rising not only in developed countries but also in the developing world. This increasing burden of CAD has led to a higher incidence of acute coronary syndrome (ACS), with 15 to 20% of ACS patients diagnosed with Non-ST Segment Elevation Myocardial Infarction (NSTEMI).[2]

Left ventricular (LV) ejection fraction (EF) and segmental wall motion analysis are commonly used to assess LV function. However, these methods are highly subjective, leading to significant inter-operator variability. The assessment of regional myocardial function via transthoracic echocardiography is a useful modality, and global longitudinal strain (GLS) by speckle tracking has become a commonly used method for evaluating CAD.[3] Myocardial deformation, an energy-intensive process, shows abnormalities early in ischemic heart disease, with the sub-endocardium, which is prone to ischemia, being predominantly involved in longitudinal mechanics. Thus, measuring myocardial strain imaging is effective for identifying CAD.[4]

Subclinical LV dysfunction in CAD patients is associated with significant obstructive CAD, and decreased GLS detected by 2D speckle-tracking echocardiography is closely linked to the severity of CAD. Literature indicates that GLS parameters are highly accurate in predicting CAD and have better sensitivity and specificity compared to traditional methods.[5] Given the subjectivity and variability of wall motion abnormalities and LV EF assessments, there is a need for a more reliable parameter to predict the severity of underlying disease, especially with the increasing burden of CAD and NSTEMI admissions.

To date, no local studies have investigated the association between GLS in NSTEMI patients with normal LV systolic function and significant CAD. Therefore, this study aims to explore the relationship between GLS and significant CAD in patients with NSTEMI who have normal LV systolic function.

METHODOLOGY

Study Design: This observational cross-sectional study was conducted to evaluate the predictive value of global longitudinal strain (GLS) in diagnosing significant coronary artery disease (CAD) in patients with non-ST Segment Elevation Myocardial Infarction (NSTEMI) who have normal left ventricular ejection fraction (LVEF).

Setting: The study was carried out at the Department of Echocardiography in collaboration with the Department of Interventional Cardiology at Chaudhary Pervaiz Elahi Institute of Cardiology, Multan, from May 1, 2023, to November 30, 2023. The study received approval from the Ethical Review Board of the institution, and informed consent was obtained from all participants.

Participants: Patients were selected using a non-probability consecutive sampling technique. Inclusion criteria were patients aged over 18 years admitted to the cardiology ward with a diagnosis of NSTEMI, confirmed by positive cardiac biomarkers (troponin I > 0.3 ng/ml) and a normal LVEF assessed via the Biplane Simpson Method. Exclusion criteria included patients with diagnosed ischemic heart disease, previous percutaneous coronary intervention or bypass grafting, left bundle branch block on ECG, paced rhythm, pre-excited atrial fibrillation, cardiomyopathies, and valvular lesions.

Variables: Data was collected on variables such as age, gender, and conventional risk factors for ischemic heart disease (IHD) including diabetes, hypertension, smoking, and dyslipidemia. The primary variable of interest was GLS, measured through speckle tracking echocardiography.

Data Sources/Measurement: Transthoracic echocardiography (TTE) was performed using a Vivid E95 machine equipped with an M5SC probe. LVEF was determined via the Biplane Simpson Method from apical four-chamber and two-chamber views, as well as by eyeballing in parasternal short-axis view. For patients with normal LVEF and no significant wall motion abnormalities, GLS was assessed using a speckle tracking technique in 2, 3, and 4 chamber apical views. GLS was calculated using a 16-segment model through automatic functional imaging, and endocardial edges of the LV were manually traced to include only the LV wall.

The software automatically detected the deformation, and the average strain value of each segment was used to derive the GLS, with >-17% considered normal. All patients subsequently underwent coronary angiography, reported by a senior interventional cardiologist who was blinded to the echocardiography and GLS findings. Significant CAD was defined as ≥50% stenosis in the left main coronary artery or ≥70% stenosis in any epicardial artery.

Bias: To minimize bias, the cardiologist interpreting the coronary angiograms was blinded to the echocardiographic findings, including GLS results. Furthermore, the echocardiograms were performed by an expert operator with extensive post-fellowship experience to ensure consistent and accurate measurements.

Study Size: The study aimed to include a sample size sufficient to detect a statistically significant difference in GLS values between patients with and without significant CAD, as determined by coronary angiography. Specific calculations for sample size were based on expected prevalence rates of CAD in the NSTEMI population and desired statistical power.

Quantitative Variables: Quantitative variables included age and GLS, which were represented by mean and standard deviation. Other quantitative data such as the degree of stenosis in coronary arteries were also considered but not the primary focus of the descriptive analysis.

Statistical Methods: Data were analyzed using SPSS version 23.0. Descriptive statistics were employed to summarize quantitative variables (age, GLS) as means and standard deviations, and categorical variables (risk factors for CAD, presence of significant CAD, and number of vessels involved) as frequencies and percentages. The relationship between risk factors, significant CAD, and GLS was assessed using the chi-square test. A p-value of <0.05 was considered statistically significant. Sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy of GLS in predicting significant CAD were calculated.

RESULTS

Participants: A total of 108 patients were included in this study. The mean age of the participants was 49.05 ± 7.28 years. There was a predominance of male patients, with 81.5% (88) being male and 18.5% (20) being female.

Descriptive Data: The prevalence of conventional risk factors for ischemic heart disease (IHD) among the patients was as follows: diabetes was present in 27.8% (30) of the patients, hypertension in 28.7% (31), and dyslipidemia in 17.6% (19). Smoking emerged as the most common risk factor, observed in 60.2% (65) of the patients.

The average global longitudinal strain (GLS) for the entire cohort was -15.02 ± 3.91%. Patients without significant coronary artery disease (CAD) on coronary angiogram had a mean GLS of -17.95 ± 3.75%, while those with significant CAD had a mean GLS of -13.56 ± 3.11%.

Outcome Data: Table 1 illustrates the distribution of GLS and the angiographic findings in the study population. Out of the 108 patients, 66.7% (72) had reduced GLS, and 33.3% (36) had normal GLS. Similarly, 66.7% (72) had significant CAD, while 33.3% (36) had no significant CAD on angiography.

The mean GLS values and their standard deviations for patients with different patterns of vessel involvement are shown below:

Table 1: Pattern of global longitudinal strain and angiographic findings

Variable	Summary
Total (N)	**108**
Global Longitudinal Strain	-15.02 ± 3.91%
Normal	36 (33.3%)
Reduced	72 (66.7%)
Angiographic Findings	
No significant coronary artery disease	36 (33.3%)
Significant coronary artery disease	72 (66.7%)
Single-vessel coronary artery disease	29 (26.9%)
Two-vessel coronary artery disease	35 (32.4%)
Triple vessel coronary artery disease	6 (5.6%)
Left main coronary artery disease	2 (1.9%)
Mean GLS by Angiographic Findings	
Single-vessel coronary artery disease	-0.14 ± 1.66%
Two-vessel coronary artery disease	-0.13 ± 4.02%
Triple vessel coronary artery disease	-0.12 ± 0%
Left main coronary artery disease	-0.14 ± 3.11%

Main Results: The relationship between GLS and conventional risk factors for CAD, as well as significant CAD on angiography, is detailed in Table 2.

The correlation between angiographic findings and GLS is depicted in Table 2. Notably, a significant p-value of <0.001 indicates that GLS can be markedly reduced even in patients with significant single-vessel disease, underscoring its diagnostic utility.

Table 2: Relation of GLS with conventional risk factors and significant CAD on angiography

Variable	Total (N)	GLS		P-value
		Normal Strain	Reduced Strain	
Gender				
Male	88	30 (34.1%)	58 (65.9%)	0.72
Female	20	6 (30%)	14 (70%)	
Co-morbid conditions				
Diabetes	30	6 (20%)	24 (80%)	0.06
Hypertension	31	12 (38.7%)	19 (61.3%)	0.45
Smoking	65	18 (27.7%)	47 (72.3%)	0.12
Dyslipidemia	19	6 (31.6%)	13 (68.4%)	0.85
Significant CAD on Angiography	72	6 (8.3%)	66 (91.7%)	0.0001
Angiographic Findings				
No vessel involved	36	30 (83.3%)	6 (16.7%)	<0.001
Single vessel disease	29	0 (0%)	29 (100%)	
Two vessel disease	35	6 (17.1%)	29 (82.9%)	
Triple vessel disease	6	0 (0%)	6 (100%)	
Left main coronary artery disease	2	0 (0%)	2 (100%)	

Regarding the predictive capability of GLS for significant CAD, Table 3 summarizes the statistics.

Table 3: Statistics of GLS in predicting significant coronary artery disease

Statistic	Value	95% CI
Sensitivity	91.7%	82.74% to 96.88%
Specificity	83.3%	67.19% to 93.63%
Positive predictive value	91.7%	84.08% to 95.82%
Negative predictive value	83.3%	69.63% to 91.60%
Accuracy	88.9%	81.40% to 94.13%

DISCUSSION

The assessment of left ventricular global longitudinal strain (GLS) is a straightforward and non-invasive procedure that can be completed in a few minutes without subjecting patients to physical stress, such as exercise. GLS is more efficient at detecting segmental ischemia and assessing global left ventricular (LV) function compared to standard transthoracic echocardiography.[6]

This study aimed to evaluate LV function using GLS in patients with non-ST Segment Elevation Myocardial Infarction (NSTEMI) who have normal LV function on standard transthoracic echocardiography and to explore its relationship with significant coronary artery disease (CAD) as determined by coronary angiography. Our findings align with those of other studies. For instance, Bhuyan et al. reported a GLS specificity of 88.89% and sensitivity of 84.62% in detecting significant CAD.[7] Similarly, Radwan et al. found a sensitivity of 93.1% and a specificity of 81.8%.[8] In our study, GLS demonstrated a sensitivity of 91.67% and a specificity of 83.33% for detecting significant CAD.

Additionally, we observed that GLS values were lower in patients with three-vessel CAD compared to those with single-vessel or two-vessel disease. This is consistent with the findings of Kumar et al. and Hoshi et al., who reported similar results in their studies. Iqbal et al. [9,10] also noted that a reduction in GLS not only indicates the presence of significant CAD but also correlates with the number of vessels involved.[11]

LIMITATION

However, this study has several limitations. Firstly, it was conducted at a single center with a small sample size. Secondly, it was a cross-sectional study without follow-up. There is a need for larger, multicenter studies with extended follow-up periods. This study could serve as a pilot for future research, forming the basis for more extensive investigations into the utility of GLS in assessing coronary artery disease in NSTEMI patients.

CONCLUSION

Global Longitudinal Strain (GLS) has demonstrated high specificity and sensitivity in detecting significant coronary artery disease (CAD). This makes GLS a valuable, non-invasive diagnostic tool for identifying significant CAD in patients with Non-ST Elevation Myocardial Infarction (NSTEMI) who have normal left ventricular systolic function on echocardiography. Given its effectiveness, GLS can be incorporated into routine clinical practice to enhance the early detection and management of CAD in this patient population, potentially improving clinical outcomes and guiding appropriate therapeutic interventions.

AUTHORS' CONTRIBUTION

MSS, AA, ARS, MT, ZZ, and TA: Concept and design, data acquisition, interpretation, drafting, final approval, and agree to be accountable for all aspects of the work. MSS, AA, ARS, MT, ZZ, and TA: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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