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Original Research Article

An observational study on global longitudinal strain in acute coronary syndrome and its correlation with coronary angiogram

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ABSTRACT

Background: Coronary angiography (CA) is crucial for diagnosing acute coronary syndrome (ACS) and assessing coronary artery disease (CAD), enabling healthcare providers to determine treatment options and assess the risk of cardiovascular events. Global longitudinal strain (GLS) is a sensitive marker of cardiac function. This study aimed to determine the correlation between GLS in ACS and CA findings.
Methods: This prospective observational study was conducted at the cardiology department of the Salem government medical college. The study involved transthoracic echocardiography (TTE) to assess LV volumes, ejection fraction (EF), and LVGLS and strain analysis using 2D echocardiography to measure regional longitudinal peak systolic strain in different LV segments. CA was performed to visualise the coronary vessels and detect significant CAD.
Results: The study population consisted predominantly of male patients (n=93, 62%), with notable smoking (n=48, 32%) and alcohol consumption (n=36, 24%). A significant majority of the patients (n=111, 74%) exhibited ECG abnormalities. Obstruction was present in 82% of the patients (n=123), with those showing impaired myocardial function compared to those without obstruction. GLS values below 13.95 were more common in patients with obstruction (n=8 out of 11), indicating reduced myocardial deformation. The GLS demonstrated excellent diagnostic performance for detecting significant coronary artery obstruction, with a high sensitivity of 88.89%, specificity of 90.63%, and overall accuracy of 90.24%.
Conclusions: Our study revealed a strong correlation between reduced GLS and CAD, highlighting its importance in CAD assessment and risk stratification in ACS. GLS demonstrated excellent diagnostic performance for detecting significant CAD, showing high sensitivity and specificity.

Keywords: ACS, Coronary angiogram, GLS, Left ventricular strain, CAD

INTRODUCTION

Acute coronary syndrome (ACS) encompasses a spectrum of conditions including unstable angina, non-ST-segment elevation myocardial infarction (NSTEMI), and ST-segment elevation myocardial infarction (STEMI). Unstable angina is characterised by chest pain or discomfort due to reduced blood flow to the heart without cell death or heart tissue damage. NSTEMI involves partial blockage of the coronary artery, leading to cell death and heart muscle damage, while STEMI results from complete blockage of the coronary artery, causing extensive heart tissue damage and cell death, commonly known as heart attack or myocardial infarction.[1]

The pathophysiology of ACS primarily involves atherosclerosis, where fatty deposits or plaques build up on the walls of the coronary arteries, leading to reduced blood flow to heart muscles. Plaque rupture or erosion triggers the formation of blood clots that obstruct blood flow, resulting in myocardial ischaemia.[2] Myocardial ischaemia occurs when the heart muscle does not receive sufficient oxygen and nutrients owing to reduced blood supply, leading to cell injury or death. This ischaemic insult can have various consequences, including unstable angina, NSTEMI, or STEMI, depending on the severity and duration of the blockage, affected myocardial area, and compensatory mechanisms.[3]

CA plays a crucial role in diagnosing ACS and in assessing CAD.[4] This imaging technique allows healthcare providers to visualise blockages or stenoses in the coronary arteries, providing essential information regarding the severity and location of coronary artery lesions.[5] By identifying areas of poor blood flow or damage to the heart, CA helps determine the extent of CAD and guide treatment decisions for patients with ACS.[6]

The importance of CA lies in its ability to directly visualise the coronary arteries, enabling healthcare providers to identify blockages that may cause myocardial ischaemia or infarction. This information is vital for determining the appropriate course of treatment, such as percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG), to restore blood flow to the heart muscles and prevent further cardiac complications. Additionally, CA aids in assessing the risk of cardiovascular events by providing detailed insights into the presence and severity of CAD, allowing for tailored management strategies based on individual patient needs.[7]

GLS, or GLS, is a measure of myocardial deformation that is assessed using echocardiography or other imaging modalities. It quantifies the degree of deformation of the myocardium during the contraction and relaxation phases, thereby providing valuable insights into myocardial function. Normal GLS values typically range from 18 to 25% in healthy individuals, with variations influenced by factors such as age, sex, and echocardiographic system.[8]

The significance of GLS lies in its ability to evaluate myocardial function and detect subtle changes in cardiac performance, particularly in the context of cardiovascular diseases. GLS serves as a sensitive marker for assessing global systolic function, offering advantages such as angle independence, fast image acquisition, reproducibility, and the ability to analyse myocardial deformation in all cardiac chambers.

In clinical practice, GLS plays a crucial role in the diagnosis and monitoring of various cardiac pathologies, including ischaemic heart disease, cardiomyopathies, and heart failure. It aids in early disease detection, prognostication, and treatment monitoring, and provides clinicians with valuable information to guide patient management and improve outcomes.[9]

Aim and objective

This study aimed to determine the correlation between GLS in ACS and CA findings.

METHODS

This prospective observational study was conducted on 150 patients with ACS based on a history of angina, ECG, ECHO, and cardiac enzymes (as per recent ACS guidelines) at the cardiology department of Salem government medical college from March 2023 to November 2023. This study was approved by the institutional ethics committee before initiation, and informed consent was obtained from all patients.

Inclusion criteria

This study included 150 patients with ACS based on a history of angina, ECG, ECHO, and cardiac enzymes (as per recent ACS guidelines) who underwent for CA.

Exclusion criteria

Exclusion criteria comprised individuals under 18 years old, those with chronic coronary syndrome, known CAD (history of myocardial infarction, previous PCI, or open-heart surgery), severe wall motion abnormalities, heart failure, atrial fibrillation, left bundle branch block, severe valvular disease, connective tissue disease, who are not willing for angiography and not giving consent were excluded.

TTE

TTE was performed using VIVID E95 with an M5Sc transducer to assess LV volumes, EF, and LVGLS.

Strain analysis

Three consecutive heart cycles were analysed using 2D grey-scale echocardiography to measure regional longitudinal peak systolic strain (RLS) in different LV segments and calculate the GLS.

CA

CA was performed via the percutaneous femoral/trans-radial approach to visualise coronary vessels and determine the presence of significant CAD (>70% stenosis).

Statistical analysis

Data were presented as mean, standard deviation, frequency, and percentage. Continuable variables were compared using the ANOVA with Post-hoc test. Cut off value was calculates using ROC and cross tabs were created to find the sensitivity and specificity.

Significance was defined by p values less than 0.05 using a two-tailed test. Data analysis was performed using the IBM-SPSS version 25.0 (IBM-SPSS Science Inc., Chicago, IL).

RESULTS

The study population consisted predominantly of males (n=93, 62%) compared to females (n=57, 38%). A notable proportion of patients reported lifestyle risk factors: smoking was present in 32% (n=48), while alcohol consumption was noted in 24% (n=36). Comorbid conditions were also prevalent, with diabetes mellitus (DM) affecting 22% (n=33) of the patients, hypertension (HTN) in 28% (n=42), and dyslipidaemia in the 26% (n=39).

A significant majority of the cohort exhibited ECG abnormalities (n=111, 74%). Among these, STEMI was the most common diagnosis, accounting for 45.3% (n=68), followed by NSTEMI at 28.7% (n=43), and unstable angina at 26% (n=39). Furthermore, obstruction was identified in 82% of patients (n=123), while 18% (n=27) did not show obstruction (Table 1).

The average EF of the study population was 51.17±4.23%. The average GLS was-16.85±1.98% (Table 2).

The mean EF for STEMI patients is 45.28±8.76, while for NSTEMI it is 48.61±8.14, and for unstable angina, it is higher at 56.14±9.12, with a significant difference (p<0.0001).

Additionally, GLS values are reported as -11.2±2.8 for STEMI, -13.9±3.9 for NSTEMI, and -14.8±3.1 for unstable angina, also showing significant differences with a p<0.0001 (Table 3).

Table 1: Patient's characteristics.

Patient characteristics		N	Percentage (%)
Age (mean±SD) (in years)		57.3±10.2	N/A
Gender	Male	93	62
	Female	57	38
Comorbidities	Smoking	48	32
	Alcohol	36	24
	DM	33	22
	HTN	42	28
	Dyslipidaemia	39	26
	ECG abnormality	111	74
STEMI	STEMI	68	45.3
	NSTEMI	43	28.7
	Unstable angina	39	26
Obstruction	Yes	123	82
	No	27	18

Table 2: ECHO.

ECHO	N
EF	51.17±4.23
GLS	-16.85

Table 3: Echocardiographic and strain analysis findings in patients with STEMI, NSTEMI, and unstable angina.

Variables	STEMI	NSTEMI	Unstable angina	P value
EF	45.28±8.76	48.61±8.14	56.14±9.12	<0.0001
GLS	-11.2±2.8	-13.9±3.9	-14.8±3.1	<0.0001

The mean EF was found to be 2.7 units lower in STEMI patients compared to those with NSTEMI, with significant difference (p=0.001). Furthermore, STEMI patients exhibited a mean EF that was 3.6 units lower than that of unstable angina patients, with significant difference (p<0.0001).

In contrast, the difference in mean EF between NSTEMI and unstable angina patients was only 0.9 units, which was not significant (p=0.419) (Table 4).

Table 4: Mean difference between STEMI, NSTEMI, and unstable angina.

Variables	Mean difference	P value
STEMI vs NSTEMI	-2.7	0.001
STEMI vs unstable angina	-3.6	<0.0001
NSTEMI vs unstable angina	-0.9	0.419

GLS values below 13.95 were more common in patients with obstruction (8 out of 11) than in those without obstruction (29 out of 32), indicating a trend towards reduced myocardial deformation in the presence of obstruction, although variability in GLS values was observed within each group (Table 5).

Table 5: Comparison of GLS between obstruction.

Variables		Obstruction	
		Yes	No
GLS	<13.95	8	3
	>13.95	1	29

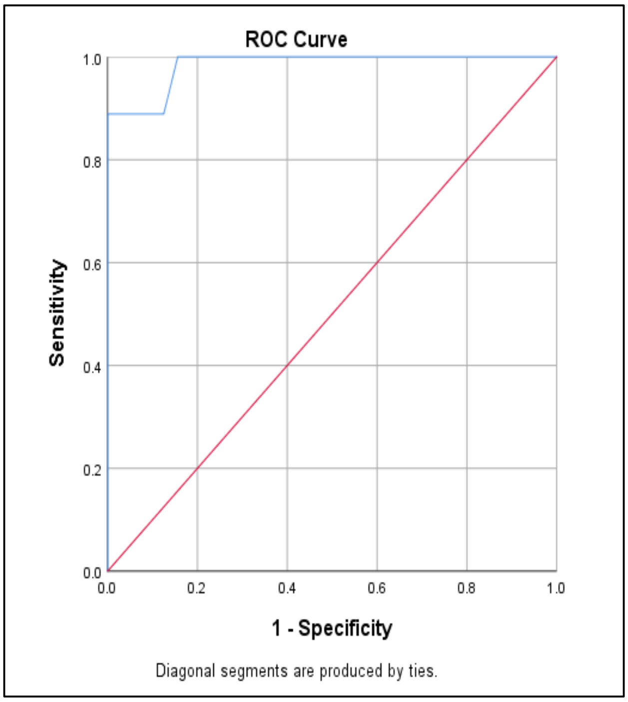

Figure 1: ROC curve of GLS.

Table 6: GLS cut-off value.

Variables	Value
Cut-off value	-13.95
AUC	0.984
P value	<0.0001
Sensitivity	88.89%
Specificity	90.63%
PPV	72.73%
NPV	96.67%
Accuracy	90.24%

The GLS demonstrated excellent diagnostic performance for detecting significant coronary artery obstruction, with a cut-off value of -13.95, as evidenced by a high area under the curve (AUC) of 0.984, statistically significant p<0.0001, and notable sensitivity (88.89%), specificity (90.63%), positive predictive value (PPV) of 72.73%, negative predictive value (NPV) of 96.67%, and overall accuracy of 90.24% (Table 6).

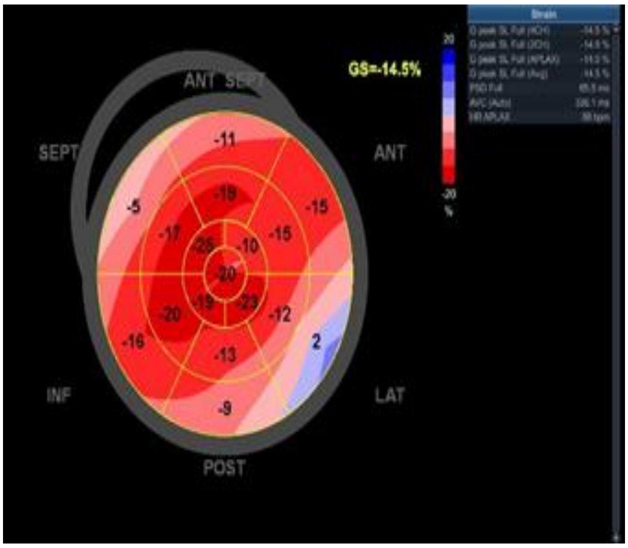

Figure 2: GLS of a patient presenting with unstable angina, CAG revealed Double vessel disease, with significant CAD in distal LAD and distal circumflex represented as bulls eye.

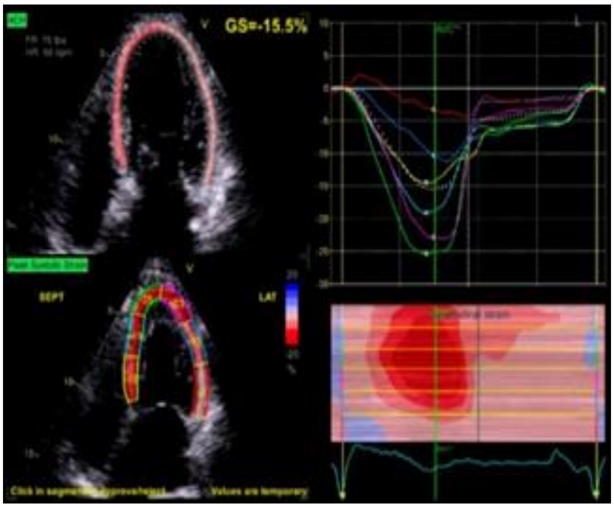

Figure 3: GLS of a NSTEMI patient, CAG revealed double vessel disease, with significant CAD in left circumflex artery.

DISCUSSION

The diagnostic potential of GLS in predicting obstructive CAD has been the subject of interest in several published studies. A comparative analysis of these studies sheds light on the consistency and variability of the GLS findings, offering valuable insights for clinical practice. Our study, characterised by a predominantly male population and significant rates of comorbidities such as DM and HTN, revealed compelling results regarding GLS and CAD. The mean EF for STEMI patients is 45.28±8.76, while for NSTEMI it is 48.61±8.14, and for unstable angina, it is higher at 56.14±9.12, with a significant difference (p<0.0001). GLS values are reported as -11.2±2.8 for STEMI, -13.9±3.9 for NSTEMI, and -14.8±3.1 for unstable angina, also showing significant differences (p<0.0001). Furthermore, GLS exhibited excellent diagnostic performance, with a cutoff value of -13.95 demonstrating high sensitivity, specificity, and overall accuracy.

Comparing these findings with those of Ng et al, Nucifora et al, Shimoni et al and Montgomery et al a consistent pattern was observed. These studies consistently demonstrated lower GLS values in patients with significant CAD than in those with non-significant CAD, reinforcing the potential of GLS as a marker of CAD presence and severity.[10-12] For instance, Ng et al reported a mean resting GLS of (16.3±2.4) in CAD-positive patients compared with (19.1±2.9) in CAD-negative patients, indicating a significant decrease in GLS associated with CAD.[10] Moreover, Shimoni et al and Montgomery et al showed the predictive value of GLS, with cutoff values of approximately 17.8% and significant differences in GLS values between the CAD-positive and CAD-negative groups. These consistent trends bolster the argument that GLS is a valuable non-invasive tool for CAD assessment.[12,13]

However, the optimal GLS cutoff value for CAD prediction varies slightly across studies, ranging from 13.95 to 17.4-19.7%. This variability can be attributed to factors such as patient demographics, imaging techniques, and software variation. Despite this variability, the consensus points towards GLS reliability in detecting significant CAD and assessing myocardial function. Gaibazzi et al further validated these conclusions by demonstrating the efficacy of GLS in predicting significant CAD (>50%) using vendor-independent software, highlighting the robustness of GLS as a diagnostic parameter across different methodologies.[14]

Biswas et al study, a cut-off value of GLS to detect significant CAD was 16.5 (87.6% sensitivity, 85.7% specificity, p<0.0001), to predict high SS was 13.5% (sensitivity 78.3%, specificity 87.9%, p<0.0001) and to predict triple vessel disease (TVD) was 14.5 (95.7% sensitivity, 73.4% specificity, p<0.0001).[15]

Bhuyan et al. evaluated during rest using 2D speckle tracking echocardiography, GLS reliably predicts the prevalence, severity, and degree of CAD. This test has a very high sensitivity and specificity. GLS has an early detection rate of 88.89% specificity and 84.62% sensitivity for severe CAD. The well-known SYNTAX and GENSINI scores show a linear but negative relationship between CAD complexity and GLS. 2-D-STE can improve echocardiography for the diagnosis of CAD by identifying high-risk individuals and providing the treating physician with more information.[16]

Fuks et al median GLS was 18.7%. MACE occurred in 47/261 (18%) of patients with worse GLS as compared with 45/264 (17%) with better GLS, adjusted HR 0.87 (95% CI 0.57-1.33, p=0.57). There was no significant difference in all-cause mortality or individual endpoints between groups. GLS did not predict MACE even in patients with optimal 2-dimensional image quality (n=164, adjusted HR=1.51, 95% CI 0.76-3.0).[17]

CONCLUSION

In conclusion, our observational study on GLS in ACS and its correlation with coronary angiogram outcomes highlights the significance of GLS as a sensitive marker for detecting obstructive CAD. The significant differences in echocardiographic parameters among STEMI, NSTEMI, and unstable angina patients suggest a need for tailored management strategies based on the type of myocardial infarction. This study revealed a clear association between reduced GLS values and CAD, particularly in patients with obstructive lesions. Our findings support the utility of GLS as an adjunctive tool in CAD assessment, offering valuable insights into myocardial function and aiding in risk stratification of patients presenting with ACS. Usually, UNSTABLE ANGINA may be having normal LVEF in conventional echo but found to have significant CAD in angiography can be diagnosed earlier with GLS.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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