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Correlation of Longitudinal Strain Imaging with Coronary Angiography in Patient with Obstructive Coronary Artery Disease without Regional Wall Motion Abnormality in 2D Echocardiography

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Abstract

*Background:*Identification of significant coronary artery disease (CAD)in NSTEMI/UA/CSA patients without invasive methodsremains a clinical challenge. Severe CAD is known to cause LV dysfunction. However, the LV ejection fraction is usually normal at a relatively early stage. Therefore, establishing a more sensitive index for the detection of early-stage LV dysfunction is of utmost importance.

Methods: This was a cross sectional observational study conducted on 136 patients with NSTEMI/UA/CSAto evaluate the value of global longitudinal strain (GLS) at rest to predict the presence of significant CAD and to determine the severity of CAD. The patients underwent transthoracic echocardiography (TTE) to measure 2D-STE to measure GLS.

*Results:*Overall, Left Anterior Descending artery(43.38%) was the commonest vessel involved. Study revealed that mean GLS value was significantly lower in significant CAD (>70% stenosis)i.e. -15.95$\pm$ 2.78 than those with non-significant CAD (<70% stenosis) i.e. -20 $\pm$ 1.73 with $p < 0.001$.The sensitivity and specificityfor SVD, DVD and TVD were67.53% andTVD were67.53% and 89.83%, 88.90% and 82.60%, 85.30% and 70.40% respectively.

*Conclusion:*Global longitudinal strain (GLS) assessed by 2D speckle tracking echocardiography at rest has good sensitivity and specificity to predict the presence, extent and severity of CAD in patients.

Key words: GLS, 2D ECHO, SVD, DVD, TVD.

INTRODUCTION

Identification of patients with significant coronary artery disease (CAD), without invasive methods, in NSTEMI/UA/CSA patients remains a clinical challenge despite the widespread use of imaging and provocative testing. More than 50% of patients currently referred for coronary angiography show normal or non-obstructive CAD. Exercise testing is widely used for selecting a patient for coronary angiography but it has its clear limitations as emphasized in the guidelines for stable CAD. Severe CAD is known to cause LV dysfunction. However, the LV ejection fraction is usually normal at a relatively early stage. Therefore, establishing a more sensitive index for the detection of early-stage LV dysfunction is of great importance.

The longitudinally arranged sub-endocardial fibres are most vulnerable to ischemic effect due to their direct exposure to the intra-ventricular blood pressure and the anatomy of the coronary circulation. As a result, the longitudinal function is impaired first in CAD. Measurements of longitudinal motion and deformation are, therefore, the most sensitive markers of coronary artery disease especially in patients with severe coronary stenosis, where intermittent ischemia may result in subtle forms of stunning that may be detectable with strain measurements. Global longitudinal strain (GLS) can be detected by two-dimensional speckle tracking echocardiography (2D-STE).

Aims and Objectives

The aim of this study was to evaluate the value of global longitudinal strain (GLS) at rest to predict the presence of significant CAD and to determine the severity of CAD in patients with the NSTEMI/UA/CSA; and to study the association of GLS with CAD.

MATERIALS AND METHODS

The present study was a cross sectional observational study conducted at S.C.B. Medical College and Hospital, Cuttack from August 2021 to November 2022.All cases included in this study were evaluated with a detailed history and relevant investigation.A total of 136 patients with the NSTEMI/UA/CSA were included.

The mean age of study subjects were56.49 ± 9.97 years. Of 136 patients, 80.9 % were males and 19.10 % were females.Hypertension (52.2%) followed by dyslipidaemia and diabetes werethe commonest observed risk factors among the study population.CSA (50.70%) was the most common diagnosis found in the study population.

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The patients underwent transthoracic echocardiography (TTE) to measure 2D-STE to measure GLS as per standard protocol and coronary angiography (CA) as per standard protocol.Images were obtained in the apical long-axis, four-chamber, and two chamber views.The regional longitudinal systolic strain was measured in 17 myocardial segments and averaged to provide global longitudinal strain (GLS).

Inclusion Criteria:

1. Age > 18 years
2. Patients with NSTEMI, Unstable Angina and chronic stable angina
3. Normal sinus rhythm
4. Adequate echo window for analysis of myocardial strain using 2 D (Two dimensional) speckle tracking echocardiography (STE) and
5. Patient must be eligible and willing for Coronary angiography.

Exclusion Criteria:

1. Patients with a previous history of myocardial infarction.
2. Patients with previous Percutaneous Coronary Interventions / CABG.
3. Patients with decompensated heart failure.
4. Patient with regional wall motion abnormality on 2D echocardiography.
5. Patients with LVEF < 50%.
6. Patients with atrial fibrillation or frequent ventricular premature complexes.
7. Conduction abnormality like LBBB.
8. Significant valvular or congenital heart disease
9. Cardiomyopathies like DCM, HCM, and RCM.

Statistical Analysis

Data was entered into computer Microsoft Excel and exported to SPSS version 20 for analysis. Continuous variables were expressed as mean ± standard deviation or median (interquartile range) and categorical variables were expressed as number (percentage). T-test and ANOVA test were used to evaluate differences in the mean value for Stenosis <70% &>70% at 95% confidence interval and $p<0.05$ was considered statistically significant. Diagnostic utility of GLPSS Score was assessed using sensitivity, specificity; positive & negative predictive value and diagnostic accuracy analysis using open epic online. Correlation between disease burden and GLPSS Score was analyzed using the Spearman correlation coefficient(r) with $p<0.05$ value as a significant correlation.

Observations and Results

In present study, 36 % of the study population had normal coronaries and 4.40 % had minor coronary artery disease i.e. stenosis <70%. Single-vessel disease (SVD), double vessel disease(DVD), and triple vessel disease(TVD) were 25.70%,14.0 %, and 14.70 % respectively. Overall, Left Anterior Descending artery(43.38%) was the commonest vessel involved. Study revealed that mean GLS value was significantly lower in significant CAD (>70% stenosis)i.e. -15.95$\pm$ 2.78 than those with non-significant CAD (<70% stenosis) i.e. -20 $\pm$ 1.73 with $p < 0.001$. Also GLS cutoff value of >/< - 18.50, predicts significant obstructive CAD with sensitivity of 89.90 % and specificity of 88.89%, with a positive predictive value of 84.48 %. The mean GLS value in SVD, DVD and TVD were -18.50±7.02, -17.00 ±2.05,-16.0 ±2.56 respectively. The sensitivity and specificityfor SVD, DVD and TVD were67.53% and 89.83%, 88.90% and 82.60%, 85.30% and 70.40% respectively (with cutoff GLS values of -18.50, -17.0 and -16.0 for SVD, DVD and TVD respectively).

Table 1: Distribution of the patients based on CAD

CAD	Frequency	Percentage
Normal	49	36
Minor CAD	6	4.4
Single vessel disease	35	25.70
Double vessel disease	19	14.0
Triple vessel disease	20	14.70
LM + double vessel disease	2	1.5
LM + triple vessel disease	5	3.7
Total	136	100.00

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Table 2: Association of severity of CAD and mean GLS values

CAD	GLS	
	Mean	**SD**
Normal	-20.02	1.76
Minor CAD	-20.88	1.43
Single vessel disease	-17.92	1.40
Double vessel disease	-14.97	2.08
Triple vessel disease	-14.25	2.85
LM + DVD	-12.35	0.35
LM + TVD	-14.1	4.08
P value	**<0.001**	

Table 3: Discriminating significant CAD from Non-significant CAD

Test	Non-Significant CAD	Significant CAD
GLS ≥ -18.5	49	9
GLS < -18.5	6	72
Total	55	81
Statistics	**Value**	**95% CI**
Sensitivity	89.90%	77.75% - 95.89%
Specificity	88.89%	79.95% - 94.79%
Positive Predictive Value	84.48	74.49 - 91.03
Negative Predictive Value	92.31	84.89 - 96.25
Accuracy	88.97%	82.46% - 93.69%

DISCUSSION

There is a considerable interest in the diagnosis of CAD prior to the development of hard endpoints (Acute coronary syndrome, Sudden Cardiac Death, etc.), which are associated with significant morbidity and mortality. A patient which has normal LV systolic function usually will have a higher threshold for investigation, especially invasive one. However, questions persist regarding the appropriateness and cost effectiveness of screening for CAD along with the optimal approach to screening.

One of the dominant cardiac imaging techniques in patients with suspected cardiac disease is echocardiography. However, conventional echocardiography has a little value in diagnosis and risk stratification of patients with suspected NSTEMI/UA/CSA, as most of these patients have a normal wall motion at rest unless there is a history of previous myocardial infarction or myocardial stunning. So, it will be beneficial if another resting module can distinguish severe CAD from less severe CAD.[4]

Global longitudinal strain measured by 2-D speckle-tracking echocardiography (2-D STE) at rest has been recognized as a sensitive parameter in the detection of significant CAD.[4]

So in the present study, we evaluated the value of GLPSS at rest to predict the presence, extent and severity of CAD in patients with suspected CAD (NSTEMI/UA/CSA) and also its correlation with angiographic severity.

Table 4: Comparison of cut-off GLS values in significant coronary artery disease with other studies
Comparison of sensitivity and specificity of GLS values for detecting significant CAD among different studies:

GLS	Tor Biering-Soerensen et al[42]	Kiran Gopinath et al[37]	Md Al Amin et al[8]	Montgomery et al[41]	Smedsrud et al[43]	Present Study
GLS in significant CAD	-17.3±2.6	-18.37±4.15	-13.5±3.4	-16.77±3.18	-17.7± 3.0	-16.1±2.68
GLS in non-significant CAD	-18.9 ± 2.6	-21.18±3.81	-19.01±2.32	-19.05±3.43	−19.5±2.6	-20±1.79
P valve	<0.001	0.003	0.001	0.0002	0.003	<0.001

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Table 5: Comparison of sensitivity and specificity of GLS values for detecting significant CAD among different studies

STUDY	Gaibazzi et al[52]	Biering-Soerensen et al[42]	Smedsrud et al[43]	Suresh Madhavan et al[36]	Kiran Gopinath et al[37]	Montgomery et al[41]	Nucifora et al[46]	Present study
Sensitivity	81.6%	74%	51%	94%	90.69% to 97.14%	66%	83%	89.90%
Specificity	84.9%	58%	81%	76%	-	76%	77%	88.89%

In our present study, we studied 136 patients, and it was seen that among those patients having significant stenosis (>70%) on coronary angiography it was revealed that GLS value was significantly lower than those with non-significant CAD (<70% stenosis) with mean values of GLS were -18.5(significant CAD) with p <0.001. Also GLS value < -18.5 may predict significant obstruction of CAD with sensitivity of 89.90% and specificity of 88.89 %, with positive predictive value of 84.48%.

Conclusion

- Accuracy of global longitudinal Strain Imaging by Speckle Tracking for Predicting Obstructive Coronary Artery Disease is around 88.97%.
- Global longitudinal strain (GLS) assessed by 2D speckle tracking echocardiography at rest has good sensitivity and specificity to predict the presence, extent and severity of CAD in patients.
- GLS has high sensitivity 89.90% and high specificity 88.89 % for early detection of significant CAD.
- 2D-STE has the potential to improve the value of echocardiography in the detection of CAD by identifying high-risk patients and to provide more information for the treating physician.
- These properties make strain imaging a good screening test to rule out significant coronary artery disease, especially when the pre-test probability is low.

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