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The Relationship between Myocardial Strain Using 2D Speckle Tracking Echocardiography and Coronary Lesion Severity Measured by Syntax Score in Patients with Chronic Coronary Syndrome at Haji Adam Malik Hospital

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ABSTRACT

Introduction: Coronary heart disease continues to be the leading cause of morbidity and death worldwide. The cardiac dysfunction known as chronic coronary syndrome is caused by atherosclerosis-related obstruction or constriction of coronary arteries. Currently, One interesting non-invasive technique is GLS assessment, which has shown to be useful in predicting coronary lesions in chronic coronary syndrome patients. This study aims to evaluated the correlation between myocardial strain based on 2-D Speckle-Tracking Echocardiography and the severity of coronary lesions in chronic coronary syndrome patients at Haji Adam Malik Hospital Medan

Method: This research is an analytical observational study with a cross sectional design on patients who diagnosed with chronic coronary syndrome and treated at H Adam Malik General Hospital Medan which met the inclusion and exclusion criteria. Sampling was carried out starting in January to December 2023. In bivariate analysis, the Fisher Exact test is used if the data is not normally distributed, and the chi square test is used if the data is normally distributed. P values less than 0.05 indicate statistical significance in data analysis using computer statistical methods.

Results: Myocardial global longitudinal strain (GLS) based on 2-D Speckle-Tracking Echocardiography was significantly associated with the severity of coronary lesions as measured by syntax score in chronic coronary syndrome patients (p value 0.0001, OR 2.732, 95% CI 1, 81-4,11). As a predictor of coronary lesions severity based on the Syntax score in patients with chronic coronary syndrome, the global longitudinal strain (GLS) cut-off value of -17.37 demonstrates a sensitivity of 92.9% and a specificity of 83.6%.

Conclusion: Myocardial global longitudinal strain (GLS) with a cut-off value of -17.37 can be used as a predictor coronary lesions severity in chronic coronary syndrome patients with a sensitivity of 92.9% and a specificity of 83.6%.

Keywords

Global longitudinal strain, Chronic coronary syndrome, Coronary lesion severity, Syntax score, 2-D Speckle-Tracking Echocardiography

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INTRODUCTION

A recently introduced 2D strain modality helps in real-time analysis of myocardial wall motion. The new modality is based on the speckle tracking echocardiography (STE) technique developed with 2D imaging and tracking of natural acoustic markers (reflectors/speckles), and has the advantage of measuring myocardial velocity, displacement and strain not only in the longitudinal direction but also in the radial and circumferential directions.[1] Global longitudinal strain (GLS) derived from speckle-tracking echocardiography (STE) can be

used to assess subclinical myocardial dysfunction.[2] GLS with 2D STE correlates well with angiographic severity of CAD and can predict significant coronary lesions with 94% sensitivity and 76% specificity in female patients with inducible angina.[3]

Myocardial fibres with a longitudinal orientation are located in the subendocardium, which is the area most susceptible to ischaemia. Assessment of longitudinal motion and myocardial deformation is the most sensitive marker of CAD using tissue Doppler imaging (TDI) or 2-dimensional strain echocardiography (2DSE).[4] Various studies have shown that STE can be optimally used to assess global and regional myocardial deformation. Abnormalities in myocardial deformation can be seen in various pathophysiological states, including myocardial ischaemia, thus helping to assess myocardial dysfunction.[5]

Global longitudinal strain (GLS) calculated by 2DSE showed that mean GLS was significantly lower in patients with significant CAD compared to non-significant CAD.[6] Coronary artery disease is generally asymptomatic or atypically expressed but can lead to more serious manifestations such as myocardial infarction or sudden death.[7] Strain imaging using 2D STE can predict the extent and severity of CAD with high diagnostic accuracy and can be used as a simple noninvasive diagnostic tool to identify patients with CAD.[8] GLS assessment to predict coronary lesions in patients with SCI is a non-invasive method that can be used especially in areas that do not have complete diagnostic facilities. This may help in the diagnosis and follow-up management of SCI patients in areas with limited facilities.

METHOD

This study was an observational analytic study with a cross sectional design to assess the relationship between myocardial strain based on 2-D Speckle-Tracking Echocardiography and coronary lesion severity in patients with chronic coronary syndrome at Hajj Adam Malik Hospital Medan. Sampling was conducted at January to December 2023.

The inclusion criteria for this study were patients with a diagnosis of chronic coronary syndrome who were admitted to H Adam Malik Hospital Medan, patients who had undergone coronary angiography at H Adam Malik Hospital Medan, patients who underwent echocardiography at H Adam Malik Hospital Medan. Patients with acute coronary syndrome, patients with congestive heart failure, patients with valvular heart disease, patients with congenital heart disease, and patients with arrhythmia were included in the exclusion criteria.

All study samples that met the inclusion and exclusion criteria were included in the study. Diagnosis of chronic coronary syndrome was made based on ESC and PERKI guidelines. Sample collection used the quota method (consecutive sampling) where each subject who met the inclusion criteria was sampled until the total number of samples was at least 35 samples for each group.

Subjects who became research samples were all patients with a diagnosis of chronic coronary syndrome at H Adam Malik Hospital Medan. Subjects' identity data (age, gender, history of hypertension, history of diabetes, history of smoking), 2-D Speckle-Tracking Echocardiography examination using Echocardiography Vivid E95 machine, and angiography examination to assess coronary artery lesions, were fully documented. The global longitudinal strain (GLS) score was calculated and confirmed by two cardiologists in the field of non-invasive cardiovascular imaging echocardiography and the SYNTAX score was confirmed by two cardiologists in the field of invasive non-surgery. Then all the data obtained will be subjected to data processing, analysis, and hypothesis testing, which have been determined using SPSS ver 26.

RESULTS

Based on angiographic results, 29 patients (52.7%) with non-significant lesion, 12 patients (21.8%) with CAD1VD, 8 patients (14.5%) with normal coronary and 6 patients (10.9%) with CAD2VD showed a score ≤ 22; while 18 patients (64.3%) with CAD3VD, 6 patients (21.4%) with CAD2VD, 4 patients (14.3%) with CAD3VD +LM showed SS > 22. Bivariate analysis with fisher exact test showed a statistically significant association between angiographic results and SYNTAX score with p value = 0.0001 ($p < 0.05$).

Table 1. Basic Characteristics of Subjects Study

Characteristic Data	Mark
Type Sex	
Man	53 (63.9%)
Woman	30 (36.1%)
Age (years)	53.9 ± 10.36
Smoking / Smoking History	28 (33.7%)
History of illness	
Hypertension	46 (55.4%)
Diabetes mellitus	29 (34.9%)
Angiography	
CAD1VD	12 (14.5%)
CAD2VD	12 (14.5%)
CAD3VD	18 (21.7%)
CAD3VD + LM	4 (4.8%)
Non-Significant Lesion	29 (34.9%)
Normal Coronary	8 (9.6%)
Syntax Score	
>22	28 (33.7%)
≤22	55 (66.3%)
Echocardiographic Parameters	
LVEF	60 (28 – 74)
GLS	-17.92 (-9 – (-25))

In addition, the mean LVEF of patients with a score ≤ 22 was 60 with a range of 46-73 and in patients with a score > 22 was 55.5 with a range of 28-74 where after the Mann Whitney test, this difference was statistically significant (p value = 0.002, p < 0.05). The mean GLS of patients with a score ≤ 22 was -20.44 with a range of (13-25) and in patients with a score > 22 was -14.1 (-9-(-24)) where after Mann Whitney test, this difference was statistically significant (p value = 0.0001, p < 0.05).

Table 2. Characteristics patient syndrome coroner chronicle based on SYNTAX score

Characteristic Data	Syntax score		P value
	≤ 22	>22	
Type Sex			
Man	27 (49.1%)	26 (92.9%)	0.0001 [a]
Woman	28 (50.9%)	2 (7.1%)	
Age	52.22 ± 11.16	57.21 ± 7.733	0.037 [d]
Smoking / Smoking History	15 (27.3%)	13 (46.4%)	0.134 [a]
History of illness			
Hypertension	27 (49.1%)	19 (67.9%)	0.016 [a]
Diabetes mellitus	13 (23.6%)	16 (57.1%)	0.005 [a]
Angiography			
CAD1VD	12 (21.8%)	0 (0%)	
CAD2VD	6 (10.9%)	6 (21.4%	
CAD3VD	0 (0%)	18 (64.3%)	0.0001 [b]
CAD3VD + LM	0 (0%)	4 (14.3%)	
Non-Significant Lesion	29 (52.7%)	0 (0%)	
Normal Coronary	8 (14.5%)	0 (0%)	
Echocardiographic Parameters			
LVEF	60 (46 – 73)	55.5 (28 – 74)	0.002 [c]
GLS	-20.44 (-13 (– 25))	-14.1 (-9 (– 24))	0.0001 [c]

Note: a, Chi Square; b, Uji Fisher Exact; c, Mann Whitney; d, Uji T Independen

For comorbidities, 28 patients (50.9%) without hypertension and 27 patients (49.1%) with hypertension showed a score ≤ 22; while 19 patients (67.9%) with hypertension and 9 patients (32.1%) without hypertension showed a score > 22. Bivariate analysis with chi square test showed a statistically significant association between hypertension comorbidity and SYNTAX score with a p value = 0.016 (p < 0.05).

Table 3. Relationship between GLS and syntax score in chronic coronary syndrome patients.

LV GLS	Syntax score		Total	P *value*	*OR*	*CI*
	>22	≤22				
≥ - 19%	1 (2.4%)	40 (97.6%)	41 (100%)	0.0001	2,732	1.81 – 4.11
< - 19%	27 (64.3%)	15 (35.7%)	42 (100%)			

Table 4. Connection between mark *GLS* with factor risk of DM and hypertension in patients syndrome coroner chronicle

Risk Factor	Yes	No	P value
DM			
GLS	-14.9 (-9 – (-22)	-19.72 (-10 – (-25))	0.001
Hypertension			
GLS	-17.55 (-9 – (-25))	-20 (-10 – (-24))	0.110

Table 5. AUC of correlated GLS values with Score syntax in patients syndrome coroner chronicle

AUC	Std. Error	Asymptotic Sig	*95% Confidence Interval*	
			Lower limit	Upper limit
0.933	0.037	0,000	0.861	1,000

The results of this study showed that in patients with LV GLS ≥ -19%, there were 1 patient (2.4%) with SYNTAX score > 22 and 40 patients (97.6%) with SYNTAX score ≤ 22. In patients with LV GLS < -19%, there were 27 patients (64.3%) with SYNTAX score > 22 and 15 patients (35.7%) with SYNTAX score ≤ 22. After bivariate analysis, a statistically significant relationship was found between global longitudinal strain (GLS) and coronary lesion severity in chronic coronary syndrome patients (p value - 0.0001, OR 2.732, 95% CI 1.81-4.11).

In this study, a lower GLS value was found in patients who had DM risk factors, namely -14.9 compared to those who did not with a GLS value of -19.72 with a p value of 0.001. There was also a lower GLS value in patients with hypertension compared to those without with GLS values of -17.55 and -20.0 respectively with a P value of 0.110.

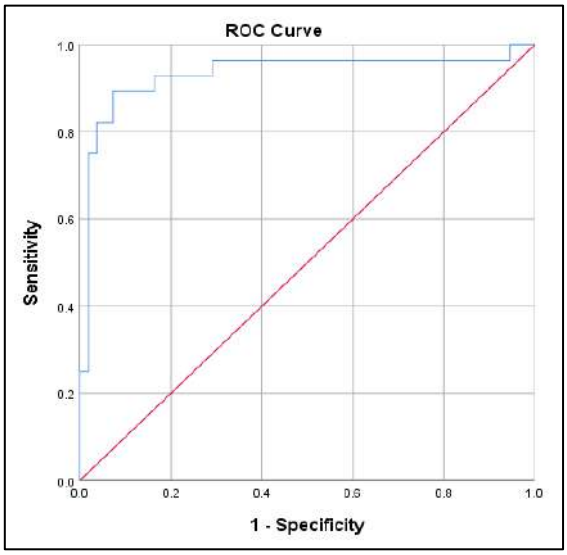

Figure 1. GLS cut-off values for predicting coronary lesion severity.

From the receiver operating characteristic (ROC) curve, the area under the ROC Curve (AUC) value for GLS value based on 2-D Speckle-Tracking Echocardiography as a predictor of coronary lesion severity based on syntax score in chronic coronary syndrome patients was 0.933 and the p value = 0.000 (p < 0.05) which showed statistical significance (95% CI 0.861-1.000). Based on these results, a cut-off value of global longitudinal strain (GLS) of -17.37 was determined, showing a sensitivity of 92.9% and specificity of 83.6%.

DISCUSSION

Bivariate analysis in this study showed a statistically significant association between gender [p = 0.0001; p < 0.05], angiography result [p = 0.0001; p < 0.05], hypertension comorbidity [p = 0.016; p < 0.05)], T2DM comorbidity [p = 0.005; p < 0.05] and SYNTAX score. Mean patient age [p = 0.037; p < 0.05], mean patient LVEF [p = 0.002; p < 0.05] and mean patient GLS [p = 0.0001; p < 0.05] were associated with SYNTAX score. However, there was no statistically significant association between smoking history and SYNTAX score with p = 0.134 (p>0.05).

After bivariate analysis in this study, a statistically significant association was found between myocardial global longitudinal strain (GLS) based on 2-D Speckle-Tracking Echocardiography and coronary lesion severity in chronic coronary syndrome patients (p value 0.0001, OR 2.732, 95% CI 1.81-4.11). Conventional echocardiography in the Bajracharya et al study showed a mean left ventricular ejection fraction (LVEF) of 66.7±4.2% and a mean left ventricular internal diameter end diastole (LVIDD) of 47.1±4.2 mm. GLS calculated by 2DSE showed that the mean GLS was significantly lower in patients with significant CAD than in patients with non-significant CAD (-16.1±2.6% vs -19.4±2.2%; p<0.001). GLS decreased gradually with increasing CAD severity as determined by the increasing number of stenotic vessels (GLS for non-significant CAD: -19.4±2.2%; single vessel disease (SVD): -16.7±2.0%; double vessel disease (DVD): -15.8±2.6%; triple vessel disease (TVD): -15.8±3.0%), which was statistically significant (p<0.001). A decrease in GLS signalled possible multivessel disease and/or a higher degree of stenosis.[2]

Global longitudinal peak systolic strain (GLPSS) values showed sensitivity to detect the number of diseased vessels with cutoff values of -20 for single vessel CAD (79.69% sensitivity and 70.27% specificity, AUC: 0.783); -18 for two vessel CAD (77.78%, 86% sensitivity specificity, AUC: 0.87) and -16 for three vessel CAD (81.82% sensitivity and 98.20% specificity AUC 0.94). The ROC curve in Yadav's study evaluating GLPSS values for CAD severity showed a GLPSS cut off value of -16 could predict CAD severity with 76.7% sensitivity and 83.3% specificity (AUC 0.84, 95% CI 0.76-0.90 P<0.0001).[6]

Non-invasive identification of patients with coronary artery disease (CAD) remains a clinical challenge despite the widespread use of imaging and provocative testing; more than 50% of patients referred for coronary angiography have normal or nonobstructive CAD. Measurement of longitudinal motion and deformation is the most sensitive marker of CAD, especially in patients with coronary stenosis, where intermittent ischaemia can result in stunning that can be detected by strain measurement.[9] The myocardial fibres most susceptible to ischaemia are those that are longitudinally orientated and located subendocardially.[10]

The need for more quantitative techniques to objectively evaluate the performance of left ventricular (LV) myocardium has led to the incorporation of new deformation indices such as two-dimensional (2D) speckle-tracking echocardiography (2D-STE). Quantification of myocardial longitudinal strain with 2D-STE has been validated, and accurately measures regional LV systolic function. It has also been shown to be superior to visual assessment of wall motion in detecting and quantifying regional myocardial ischaemia.[11]

In this study, based on the Area under the ROC Curve (AUC) results, a global longitudinal strain (GLS) cut-off value of -17.37 was determined, showing a sensitivity of 92.9% and specificity of 83.6%.

Similar to the results of this study, the study of Montgomery et al found a GLS cut-off > -17.77% had the most optimal sensitivity and specificity (66/76%) for detecting CAD and was comparable to wall motion score index (WMSI) ⩾ 1.13 (68/70%) measured during stress.39 In addition, the cut-off value for peak systolic longitudinal strain in Smedsrud et al was 17.4 with 81% specificity and 51% sensitivity.[12]

CONCLUSION

Myocardial global longitudinal strain (GLS) with a cut-off value of -17.37 can be used as a predictor coronary lesions severity in chronic coronary syndrome patients with a sensitivity of 92.9% and a specificity of 83.6%.

DECLARATIONS

None

CONSENT FOR PUBLICATION

The Authors agree to publication in Journal of Society Medicine.

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COMPETING INTERESTS

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTIONS

All authors significantly contribute to the work reported, whether in acquisition of data, analysis, and interpretation, or in all these areas. Contribute to drafting and revising. Approved the final version to be published, agreed on the journal to be submitted, and agreed to be accountable for all aspects of the work.

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