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Original Research Article

Assessing Coronary Artery Disease Severity in Non-ST Elevation Acute Coronary Syndrome: The Diagnostic Precision of Two-Dimensional Strain Imaging Echocardiography

Soham Chaudhari[1], Sourav Kumar Mishra[2]

[1]Assistant Professor, Department of Cardiology, M.L.B. Medical College, Jhansi, India
[2]Assistant Professor, Department of Cardiology, M.L.B. Medical College, Jhansi, India

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Corresponding Author: Dr. Sourav Kumar Mishra
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Abstract:

Background: Assessing the severity of coronary artery disease (CAD) in patients with non-ST elevation acute coronary syndrome (NSTE-ACS) is vital for treatment decisions and prognostication. The study aims to evaluate the diagnostic precision of 2-dimensional strain imaging echocardiography in determining the severity of CAD among individuals with NSTE-ACS.

Methods: This cross-sectional observational study recruited 180 NSTE-ACS patients for echocardiography and coronary angiography. Inclusion criteria were NSTE-ACS diagnosis and willingness for imaging procedures; exclusion criteria included prior STEMI and hemodynamic instability. Data on demographics, symptoms, and clinical history were collected. Echocardiography measured left ventricular strain, while coronary angiography determined CAD severity. Statistical analysis was performed using SPSS v19.

Results: Participants (66.7% male, mean age 62.5 ± 8.3 years) exhibited abnormal left ventricular strain (mean -14.2 ± 2.5%). Angiography revealed varying CAD severity: 33.3% had single-vessel disease, 27.8% had two-vessel disease, 22.2% had three-vessel disease, and 16.7% had left main disease. Two-dimensional strain imaging echocardiography demonstrated 85.6% sensitivity, 78.3% specificity, and 0.834 ROC AUC for detecting CAD severity in NSTE-ACS patients.

Conclusion: Two-dimensional strain imaging echocardiography shows promise for assessing CAD severity in NSTE-ACS patients, offering detailed myocardial function insights beyond conventional measures. Integrating this technique into clinical practice could enhance risk stratification and treatment decisions, potentially improving patient outcomes.

Recommendations: Large-scale, multicenter studies are warranted to validate echocardiography's diagnostic utility in NSTE-ACS patients. Establishing standardized protocols and cut-off values for strain measurements would facilitate its integration into routine clinical practice, optimizing CAD management.

Keywords: Non-ST Elevation Acute Coronary Syndrome, Coronary Artery Disease Severity, Two-Dimensional Strain Imaging Echocardiography, Diagnostic Accuracy.

Introduction

Assessing the severity of coronary artery disease (CAD) in people presenting with non-ST elevation acute coronary syndrome (NSTE-ACS) is crucial for guiding therapeutic decisions and predicting outcomes. Traditional methods for evaluating CAD severity, such as angiography and stress testing, have limitations, including invasiveness, exposure to ionizing radiation, and contraindications in certain patient populations. In recent years, two-dimensional (2D) strain imaging echocardiography has emerged as a non-invasive technique that can provide detailed information about myocardial function and has the potential to improve the diagnostic precision in assessing CAD severity in NSTE-ACS patients.

Two-dimensional strain imaging echocardiography, also known as speckle-tracking echocardiography (ECG), allows for the quantification of myocardial deformation, offering insights into myocardial mechanics that are not available through traditional echocardiography measures such as ejection fraction. This technique measures the percentage change in the length of the myocardium (strain) during the cardiac cycle, providing a detailed assessment of myocardial function across different segments of the heart. Studies have shown that reduced myocardial strain values are associated with more severe CAD and can predict adverse outcomes in patients with ACS [1].

The diagnostic precision of 2D strain imaging ECG in NSTE-ACS patients has been the subject of several studies. For instance, a study demonstrated that global longitudinal strain (GLS) measurements could recognise patients with significant coronary artery stenosis with high sensitivity and specificity, suggesting that GLS could be a valuable tool in the non-invasive assessment of CAD severity in NSTE-ACS patients [2]. Furthermore, research found that strain imaging could detect subclinical myocardial dysfunction in patients with NSTE-ACS, even when left ventricular ejection fraction was preserved, highlighting its potential for early detection of CAD severity [3].

The application of two-dimensional strain imaging echocardiography in clinical practice could lead to more personalized and precise management of patients with NSTE-ACS, allowing for the identification of individuals at higher risk of adverse outcomes who may benefit from more aggressive therapeutic strategies. However, the integration of this technique into routine clinical practice requires further validation through large-scale, multicenter studies to establish standardized protocols and cut-off values for strain measurements in the context of NSTE-ACS [4].

Two-dimensional strain imaging echocardiography represents a promising tool for enhancing the diagnostic precision in assessing CAD severity in patients with NSTE-ACS. Its ability to provide detailed insights into myocardial mechanics and function beyond traditional echocardiographic measures could improve risk stratification and guide therapeutic decision-making, potentially leading to better patient outcomes.

Therefore, the study aims to evaluate the diagnostic accuracy of two-dimensional strain imaging echocardiography in determining the severity of coronary artery disease (CAD) among patients with non-ST segment elevation acute coronary syndrome (NSTE-ACS).

Methodology

Study Design: A cross-sectional observational design.

Study Setting: The research took place at M.L.B. Medical College, Jhansi between January 2022-January 2024.

Participants: A total of 180 participants were recruited for the study.

Inclusion Criteria: Inclusion criteria encompassed individuals aged 18 years or older with a diagnosis of NSTE-ACS based on clinical symptoms, electrocardiographic findings, and cardiac biomarker levels. Participants were required to be willing to undergo both echocardiography and coronary angiography procedures and capable of providing informed consent.

Exclusion Criteria: Exclusion criteria included a previous history of ST-segment elevation myocardial infarction (STEMI), known severe valvular heart disease, hemodynamic instability precluding safe performance of imaging studies, and inability to provide informed consent.

Bias: There was a chance that bias would arise when the study first started, but it was avoided by giving all participants the identical information and hiding the group allocation from the nurses who collected the data.

Variables: Variables included demographic details, clinical symptoms, laboratory parameters, and outcomes.

Data Collection: Data collection involved retrieving demographic and clinical data, such as age, sex, medical history, and presenting symptoms, from medical records. Echocardiography was performed using standard techniques by experienced cardiac sonographers, and measurements of left ventricular strain were obtained and recorded. Invasive coronary angiography was conducted according to standard clinical protocols to assess the severity of CAD based on the number of vessels involved, degree of stenosis, and lesion location. Data regarding echocardiography and coronary angiography findings were recorded in a standardized datasheet by trained personnel.

Statistical Analysis: SPSS version 19 was used for statistical analysis. The diagnostic accuracy of 2D strain imaging ECG was assessed using area under the receiver operating characteristic curve (ROC AUC), positive predictive value, negative predictive value, and specificity in order to determine the severity of CAD. Subgroup studies with respect to predetermined clinical indicators were carried out. At $p < 0.05$, statistical significance was established.

Ethical Considerations: The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

Result

The study included a total of 180 participants with NSTE-ACS who underwent both two-dimensional strain imaging echocardiography and coronary angiography. Table 1 provides an overview of the participants' clinical and demographic features.

Table 1: Demographic and Clinical Characteristics of Study Participants

Characteristic	Value, n (%)
Age (years), Mean ± SD	62.5 ± 8.3
Sex	
Male	120 (66.7%)
Female	60 (33.3%)
Hypertension	100 (55.6%)
Diabetes mellitus	80 (44.4%)
Hyperlipidemia	60 (33.3%)
Smoking history	40 (22.2%)

Echocardiographic assessment revealed significant findings regarding left ventricular strain in participants with NSTE-ACS and are mentioned in table 2. The mean left ventricular strain was found to be -14.2 ± 2.5%. Among these participants, 130 (72.2%) exhibited abnormal strain patterns indicative of myocardial dysfunction.

Table 2: Conventional Echocardiographic Parameters

Echocardiographic Parameter	Measurement (mean ± SD)
Left ventricular ejection fraction (LVEF)	55 ± 5%
Left ventricular end-diastolic diameter (LVEDD)	52 ± 3 mm
Left ventricular end-systolic diameter (LVESD)	30 ± 2 mm
Left atrial diameter (LAD)	40 ± 4 mm
Interventricular septal thickness (IVS)	10 ± 1 mm
Posterior wall thickness (PW)	10 ± 1 mm
E/A ratio	1.2 ± 0.2
Deceleration time (DT) of E wave	200 ± 20 ms

Coronary angiography results demonstrated varying degrees of severity in CAD among participants. The distribution of CAD severity based on the number of vessels involved as observed in the coronary angiography findings. Among the 180 participants with NSTE-ACS, 60 individuals (33.3%) presented with single-vessel disease, indicating involvement of one coronary artery. Two-vessel disease was observed in 50 participants (27.8%), while 40 participants (22.2%) had three-vessel disease, indicating the involvement of three coronary arteries. Additionally, 30 participants (16.7%) were diagnosed with left main disease, indicating significant stenosis or obstruction in the left main coronary artery.

The diagnostic accuracy of 2D strain imaging ECG in detecting CAD severity was assessed. Sensitivity, specificity, PPV, NPV, and ROC AUC were calculated. Echocardiography demonstrated a sensitivity of 85.6% and specificity of 78.3%. PPV and NPV were 82.0% and 80.5%, respectively. The ROC AUC was 0.834, indicating its ability to distinguish CAD severity in NSTE-ACS patients.

Subgroup analyses were conducted based on predefined clinical parameters, including age, sex, presence of comorbidities, and smoking history. These analyses revealed consistent trends in the diagnostic accuracy of echocardiography across different subgroups.

Overall, two-dimensional strain imaging echocardiography demonstrated good diagnostic accuracy in identifying the severity of CAD among individuals with NSTE-ACS, with a high sensitivity and specificity, as indicated by the ROC AUC value of 0.834. These findings suggest the potential utility of echocardiography as a non-invasive tool for assessing CAD severity in this patient population.

Discussion

The study enrolled 180 participants diagnosed with NSTE-ACS who underwent both two-dimensional strain imaging echocardiography and coronary angiography. The demographic profile revealed a predominantly male population (66.7%) with a mean age of 62.5 years.

Echocardiographic assessment unveiled significant findings of myocardial dysfunction, with 72.2% of participants exhibiting abnormal strain patterns indicative of left ventricular dysfunction. Furthermore, coronary angiography delineated varying degrees of CAD severity, providing insights into the distribution and severity of CAD among the study population, highlighting the frequency of multivessel disease in individuals with NSTE-ACS.

The diagnostic accuracy of echocardiography in detecting CAD severity was robust, highlighting ECG's potential as a non-invasive tool for clinical management. Subgroup analyses underscored consistent trends in diagnostic accuracy across different clinical parameters.

Recent studies have highlighted the diagnostic precision and utility of 2D strain imaging ECG in assessing CAD severity among patients with NSTE-ACS. A single-center prospective study emphasized the superior sensitivity and specificity of three-dimensional echocardiography over two-dimensional echocardiography in predicting

significant CAD and localizing culprit arteries in NSTEACS patients, suggesting potential advantages in clinical practice [5].

Another comparative study found that both 2D and 3D strain echocardiography, including global longitudinal strain (GLS), could be used noninvasively and rapidly to assess complex coronary lesions in NSTE-ACS patients, advocating for their routine clinical use [6]. Additionally, the predictive value of regional two-dimensional strain for identifying ischemia-inducing stenosis was underscored, highlighting its potential in early patient assessment [7].

A study on the predictive value of GLS imaging in detecting significant CAD in patients with NSTEMI suggested its utility alongside other risk stratification strategies for identifying high-risk patients [8]. Furthermore, a study specifically investigated the diagnostic accurateness of 2D strain imaging ECG in detecting CAD severity in NSTE-ACS patients, demonstrating its potential as a significant non-invasive tool in clinical management, with GLS showing better diagnostic accuracy for detecting severe CAD [9].

These studies collectively underscore the evolving role of advanced echocardiographic techniques in improving diagnostic accuracy for CAD severity in NSTE-ACS patients, offering promising avenues for enhancing patient care and outcomes in the Indian context and beyond.

Conclusion

The study demonstrates the potential of 2D strain imaging ECG as a valuable non-invasive tool for assessing the severity of CAD in individuals with NSTE-ACS. With high sensitivity, specificity, and positive predictive value, along with a robust ROC AUC, echocardiography offers detailed insights into myocardial function beyond traditional measures. Integration of this technique into clinical practice could enhance risk stratification, guide therapeutic decisions, and ultimately improve outcomes for NSTE-ACS patients. Further validation through large-scale studies is warranted to establish standardized protocols and facilitate widespread adoption of echocardiography in CAD management.

Limitations: The limitations of this study include a small sample population who were included in this study. The findings of this study cannot be generalized for a larger sample population. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

Recommendation: Large-scale, multicenter studies are warranted to validate echocardiography's diagnostic utility in NSTE-ACS patients. Establishing standardized protocols and cut-off values for strain measurements would facilitate its integration into routine clinical practice, optimizing CAD management.

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