# Correlation between Stress Echocardiography and Coronary Angiography Results: Insights from 134 Cases

**Ichrak FADAOUI[1], Zineb Agoumy[2], Aida Soufiani[3], Nesma Bendagha[4], Rokya Fellat[5]**

[1,2,3,4,5] Cardiology A department, Ibn Sina Hospital, Rabat, Morocco

| ARTICLE INFO | ABSTRACT |
|---|---|
| **Published Online:** 22 March 2025 | **Background:** Stress echocardiography is widely used to assess myocardial ischemia. The objective of this study was to investigate the correlation between stress echocardiography results and coronary angiography findings, and to analyze the factors influencing these parameters.<br>**Methods:** This retrospective study analyzed 134 patients referred to the Cardiology A Department of Ibn Sina Hospital in Rabat. After confirmation of positive stress echocardiography, coronary angiography was performed. The inclusion criteria were patients aged 18 years and older with complete test results. Exclusion criteria included recent myocardial infarction, uncontrolled arrhythmias, severe aortic stenosis, heart failure class III or IV, inability to perform an exercise test, advanced respiratory diseases, history of coronary artery disease, and incomplete or poor-quality data.<br>**Results:** The average age of the patients was 58 years, with a predominance of men (53%). Indications for stress echocardiography were primarily symptoms of coronary artery disease in 87% of patients. The ischemic territory was mainly the left anterior descending artery (LAD) in 49.7% of patients. This is consistent with the findings observed in coronary angiography. 25.4% of patients with positive stress echocardiography had normal coronary angiography. Factors associated with non-significant angiographic coronary artery disease included younger age, female gender, absence of diabetes, absence of hypertension history, and negative stress ECG results.<br>**Conclusion:** The main advantages of stress echocardiography lie in its availability, low cost, and non-irradiating nature. Its main limitation is the subjective nature of its interpretation, which requires a skilled and qualified operator. Our study indicated that the results of stress echocardiography and coronary angiography had a positive correlation. This non-invasive examination is reliable for the diagnosis and prognosis of coronary artery disease. |
| Corresponding Author:<br>**Ichrak FADAOUI** | |
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## INTRODUCTION

Coronary artery disease is a major cause of global mortality. Early diagnosis is crucial for better clinical outcomes and to optimize therapeutic strategies. Stress echocardiography is a widely used non-invasive imaging technique, particularly for assessing myocardial ischemia. However, its diagnostic accuracy varies, and confirmation by coronary angiography, which is the gold standard for detecting coronary stenosis, is often necessary.

### Objective of the Study

To investigate the correlation between stress echocardiography results and coronary angiography findings, and to analyze the factors influencing these parameters.

## METHODOLOGY

This is a retrospective analysis of 134 patients who underwent both stress echocardiography and coronary angiography at the Cardiology A Department of Ibn Sina University Hospital Center in Rabat between November 2021 and October 2023. The inclusion criteria included:

- Patients aged 18 years and older.
- Patients with complete results for both stress echocardiographies and coronary angiographies.

The exclusion criteria included:

- Patients with contraindications to the examination (recent myocardial infarction, uncontrolled arrhythmias, symptomatic severe aortic stenosis, heart failure class III or IV, inability to perform an

exercise test due to physical or neurological limitations, advanced respiratory diseases).

- Patients with a history of coronary artery disease (coronary angioplasty or coronary artery bypass grafting).
- Patients with incomplete or poor-quality data.

## Stress Echocardiography with Exercise

Physical exercise remains the most physiological method. The test is performed on an ergometric bicycle with 25 Watts increments every 2 minutes. A 12-lead electrocardiogram (ECG), blood pressure (BP), and heart rate are monitored. Reported clinical symptoms are noted. Echocardiographic images are acquired at rest and throughout the exercise, as well as during recovery, using different views: apical four-chamber, three-chamber, two-chamber, and parasternal long-axis and short-axis views.

### Table 1: Demographic and Clinical Characteristics of Patients

| Characteristics | Values |
|---|---|
| Mean Age | 58 years |
| Gender | 53% male |
| Hypertension | 66,4% |
| Diabetes | 56,8% |
| Smoking | 24,8% |
| Hypercholesterolemia | 30,4% |
| Family History of CAD | 6,4% |

## Data Related to Stress Echocardiography

In our cohort, 83% of our patients were symptomatic. The indications for stress echocardiography included symptoms suggestive of coronary artery disease in 87% of patients: 72% presented with chest pain (20% typical angina and 52% atypical angina) and 15% had exertional dyspnea, palpitations in 5%, pre-kidney transplant evaluation in 5 patients (4%), multi-arterial assessment in 2%, and 2% for evaluation of ventricular extrasystole (Table 2).

### Table 2: Indications for Stress Echocardiography

| Indication | Pourcentage / Nombre de patients |
|---|---|
| Symptoms suggestive of coronary artery disease | 87% |
| - Typical angina | 20% |
| - Atypical angina | 52% |
| - Exertional dyspnea | 15% |
| Pre-kidney transplant evaluation | 4% |
| Palpitations | 5% |
| Multi-arterial assessment | 2% |
| Evaluation of ventricular extrasystole | 2% |

In 82% of patients, the desired frequency of at least 85% of the maximum heart rate (HR max) was achieved. The maximum frequency reached was on average 94% of the HR max, with extremes ranging from 50% to 100%. The average peak systolic blood pressure was 177 mmHg. Electrically, the baseline ECG was normal in 60% of patients, a left bundle branch block (LBBB) was observed in 9%, and ventricular extrasystoles in 4%. During the examination, electrical changes were observed in 56.2%; 3 patients (2.3%) presented with non-sustained monomorphic ventricular tachycardia; no electrical changes were recorded in 37%. Echocardiographically, the affected myocardial segments and the territory of ischemia are detailed in Table 3. The ischemic threshold was intermediate in 58.9% of patients and low in 31.6%. The territory of ischemia was mainly in the LAD in 49.7% of patients and in the right coronary artery (RCA) in 27.3%. The main criterion for stopping the test was exhaustion observed in 24%, and the appearance of ischemia in 67%. The test was considered clinically positive in the event of chest pain, whether typical or not, or electrically and echocardiographically in the case of segmental wall motion abnormalities: reduced thickening (hypokinesia), absence of thickening (akinesia), paradoxical systolic motion (dyskinesia) of the myocardial wall. Seven patients (5%) experienced symptomatic hypertensive peaks, 3% had an arrhythmia, and 1% had a vasovagal syncope.

### Table 3: Distribution of ischemic territories in patient

| Territory of Ischemia | Percentage |
|---|---|
| Left anterior descending artery | 49,7% |
| Right coronary artery | 27,3% |
| Circumflex artery | 11% |
| Left marginal artery | 9% |
| Diagonal artery | 3% |

## Coronary Angiography Results

Coronary angiography revealed significant coronary stenoses in 74.6% of patients, while it was normal in 19.4% of patients. Additionally, 4.6% of patients had non-significant coronary lesions. The locations of the stenoses are illustrated in Table 4. The LAD was the most frequently affected, impacting 43,9% of patients, followed by the RCA with 25.7%.

### Table 4: Coronary Angiography Results

| Location of Significant Stenosis | Percentage |
|---|---|
| Left anterior descending artery | 43,9% |
| Right coronary artery | 25,7% |
| Circumflex artery | 12,1% |
| Left marginal artery | 10,5% |
| Diagonal artery | 3,8% |
| Left main artery | 2% |
| Posterior interventricular artery | 2% |

## DISCUSSION

Stress echocardiography is among the first-line non-invasive tests (class I) in the 2023 recommendations of the European Society of Cardiology (ESC) on chronic coronary syndromes. It is preferred over coronary CT angiography in cases of high probability of coronary artery disease [1].

Physical exercise remains the most physiological method and should be preferred whenever possible. The study by Beleslin et al. [2] involved 136 patients who underwent stress echocardiography with exercise and with dobutamine for the detection of ischemia, followed by coronary angiography. The results showed that exercise stress echocardiography was more sensitive (88% vs 82%) and more specific than dobutamine stress echocardiography.

The characteristics of our population reflect a high cardiovascular risk population, given that 51% of patients had at least two cardiovascular risk factors. The results of our study show that 25.4% of patients with a positive stress echocardiography have normal coronary angiography. This warrants further analysis and can be explained by several pathophysiological mechanisms. A Korean study found that 24% of stress echocardiography results were false positives in the studied population. False positives were more likely to involve men and diabetic patients [3]. A Mayo Clinic study found that among 1,477 patients, 32.5% had false-positive results on stress echocardiography [4].

In our study, multivariate analysis revealed that younger age, female gender, absence of diabetes, absence of a history of hypertension, and negative results on stress ECG were associated with non-significant coronary artery disease on angiography (normal coronary angiography or coronary lesions < 50%) (Table 5).

**Table 5: Factors Associated with False Positives**

| Variable | Odds Ratio (OR) | 95% Confidence Interval (CI 95%) | P-value |
|---|---|---|---|
| **Younger age** | 0.80 | 0.65 - 0.95 | 0.02 |
| **Female gender** | 0.85 | 0.72 - 1.00 | 0.04 |
| **Absence of diabetes** | 0.60 | 0.50 - 0.75 | < 0.001 |
| **Absence of hypertension history** | 0.70 | 0.55 - 0.85 | 0.003 |
| **Negative stress ECG** | 0.50 | 0.40 - 0.65 | < 0.001 |

Stress echocardiography helps detect abnormalities in contractile reserve under induced stress. Abnormalities in coronary microcirculation or coronary spasms can lead to false positives. A study examined the characteristics of patients with positive stress echocardiography and non-significant coronary artery disease, with only a small number of patients undergoing intracoronary physiological tests at the time of coronary angiography. Four of the six patients with angiographically normal coronary arteries who underwent intracoronary acetylcholine provocation tests developed coronary vasospasm, indicating endothelial dysfunction [5].

The results of stress echocardiography can be influenced by variables such as preload, afterload, and the individual patient's response to stress. These hemodynamic variables can produce false positives that do not necessarily reflect significant coronary pathology on coronary angiography. The timing of diagnostic tests plays a crucial role. Transient myocardial ischemias induced by a stress test, such as Takotsubo cardiomyopathy or apical ballooning syndrome, have been reported to occur with exercise stress or dobutamine stress, and various stress imaging modalities, including nuclear scintigraphy, echocardiography, and magnetic resonance imaging [6; 7].

In patients with left ventricular hypertrophy, false positives may occur. Delayed apical contraction of the inferoseptal and inferior walls can simulate LAD ischemia. A Doppler shot in the outflow tract revealing a sub-aortic gradient > 50 mmHg, accompanied by systolic anterior motion (SAM), can explain this delay. If apical kinetics normalize with the disappearance of the gradient, the phenomena are linked. Otherwise, an LAD stenosis is suspected. Sometimes, a clear distinction remains difficult. In cases of LBBB, septal dyssynchrony observed in these cases can be confused with ischemia-induced abnormalities. This abnormal ventricular septal motion can also result from right ventricular pacing or open-heart surgery, creating situations where these conditions are mistaken for ischemia-induced abnormalities.

A study examined the impact of a hypertensive response during stress echocardiography. It concluded that an excessive increase in blood pressure during exercise is associated with an increased probability of new wall motion abnormalities, even in the absence of significant coronary stenosis on angiography. These false-positive results were more frequent in hypertensive responders (63%) compared to non-hypertensive responders (36%) [8].

Even if coronary angiography does not show significant lesions, an impaired coronary reserve can still have negative prognostic implications. This study identified 32.5% of false positives among the studied population, who had comparable 1-year and 3-year survival rates with true positive patients [5]. This was also confirmed by another study showing that the overall survival of patients with stenoses < 50% was similar to that of patients with stenoses > 50% for stress echocardiography [9]. Another study indicated that patients with false-positive results on stress echocardiography are at higher risk of cardiovascular events than those with negative results, regardless of angiographic findings [10].

The terms INOCA (Ischemia with Non-Obstructive Coronary Arteries) and ANOCA (Angina with Non-Obstructive Coronary Arteries) are recent concepts, officially recognized and defined in the guidelines of ESC [1]. They designate patients presenting with symptoms of myocardial ischemia or

angina without significant obstruction of the coronary arteries. This allows for better management and more appropriate treatment of these patients. Therefore, it is essential to better characterize patients with false-positive stress test results in future research to define suitable treatments and potentially improve their long-term prognosis. A meta-analysis of 44 studies [11] focusing on patients with no history of coronary artery disease undergoing coronary angiography due to a positive test showed that stress echocardiography had a sensitivity of 85% and a specificity of 77% for detecting coronary artery disease, compared to a sensitivity of 87% and a specificity of 64% for scintigraphy. In our study, stress echocardiography correctly identified ischemic territories, with the LAD and right coronary artery being the main affected areas, corresponding to coronary angiography results. This correlation supports the diagnostic efficacy of stress echocardiography in detecting significant coronary stenoses.

Our study has some limitations. Being retrospective, it is subject to selection and memory biases. Furthermore, the sample size may not be large enough to generalize the results to the entire population. Since only patients with positive stress echocardiography underwent coronary angiography, it was impossible to evaluate the sensitivity and specificity of stress echocardiography.

## CONCLUSION

The main advantages of stress echocardiography lie in its availability, low cost, and non-irradiating nature. Its main limitation is the subjective nature of its interpretation, which requires a skilled and qualified operator. Our study indicated that the results of stress echocardiography and coronary angiography had a positive correlation. This non-invasive examination is reliable for the diagnosis and prognosis of coronary artery disease.

## LIST OF ABBREVIATIONS

LAD: Left anterior descending artery
RCA: Right coronary artery
ECG: Electrocardiogram
BP: Blood pressure
HR max: Maximum heart rate
LBB: Left bundle branch block
ESC: European Society of Cardiology
SAM: Systolic anterior motion
INOCA: Ischemia with Non-Obstructive Coronary Arteries
ANOCA: Angina with Non-Obstructive Coronary Arteries

## FUNDING

## CONSENT

Informed written consent was obtained from patients to publish his clinical data.

## ETHICAL APPROVAL

It is not applicable.

## ACKNOWLEDGEMENTS

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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