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Clinical Relevance of Chest Pain during Dobutamine Stress Echocardiography

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ORIGINAL ARTICLE

Clinical Relevance of Chest Pain During Dobutamine Stress Echocardiography

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Abstract

Introduction: **Chest pain is a common presentation in emergency units in daily life. Dobutamine stress echocardiography (DSE) was considered an early non-invasive method that help stratifying the risk for development of CVD. However, many patients experience chest pain shortly after DSE.**

Aim of study: **Assess the relevance between chest pain during DSE in those who are negative for DSE and presence of atherosclerosis in coronary angiography.**

Methods: **One hundred and fifty patients admitted to catheter unit in Cardiology Department at Al-Hussein Hospitals between June 2021 and June 2022 with chest pain despite negative DSE. They all underwent coronary angiography.**

Results: **The median age of patients was 50.99 ± 8.29 years old. 56.7% of patients were males. 24.7% of patients were diabetic. After PCA, 15.3% of patients had severe coronary arteries stenosis. We found that 6% of patients had severe stenosis of Left anterior descending and right main coronary arteries ($P < 0.001$). In addition, DM with other risk factors was significantly connected with development of severe stenosis of coronary arteries ($P < 0.001$).**

Conclusion: **15.3% of patients with chest pain following DSE had significant coronary arteries stenosis on PCA. DM was associated with that stenosis. That is why, in patients with negative DSE and chest pain, further investigations are required. Special emphasis should be directed to patients with more than one risk factor including diabetes mellitus.**

Keywords: Chest pain, Dobutamine echo, Stress echocardiography

1. Introduction

Each year, emergency departments (EDs) in USA treat more than 7 million patients with chest discomfort. Recent estimates place the lifetime prevalence of chest discomfort among patients in USA between 20 and 40%. The overwhelming majority of these patients have noncardiac causes. On the contrary, 5.1% of them are diagnosed with CAD.[1]

Several noninvasive cardiac examinations available to get an appropriate diagnosis; DSE is often used to those who cannot exercise when CAD is suspected.[2] Dobutamine stress echocardiography (DSE) is still the test of preference for swiftly classifying people who have ischemic heart disease because of its excellent accuracy, strong NPV, ease of accessibility, and safety.[3]

Dobutamine infusion may cause headache, nausea, flushing, urine urgency, UTI, and chest pounding. Hypotension, myocardial infarction, and coronary artery spasm (chest pain) were less common.[4]

One in 2000 DSE patients have DSE develop chest discomfort after 2 h, according to Geleijnse et al. Some people feel chest discomfort during the treatment, while others do so afterward. Variation in chest discomfort onset depends on when thrombus forms over a plaque.[5]

There is a limited evidence concerning the underlying cause of that chest pain especially if DSE was negative. So, we tried to investigate for the

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pathology using invasive percutaneous coronary angiography (PCI) in order to determine the degree of stenosis of coronaries.

We aimed to assess the relevance between chest pain during DSE in those who are negative for DSE and presence of atherosclerosis in coronary angiography.

2. Patients and methods

Between June 2021 and June 2022, prospective research was done at the Al-Hussein and Bab AL She'rey Al-Azhar University Hospitals. One hundred and fifty patients over the age of 18 were brought to the catheter unit with chest discomfort despite a negative dobutamine stress echo.

Patients with one or more of the following criteria were excluded:

(1) Poor Echo window.
(2) Uncontrolled systemic hypertension, defined as 180/110 mm Hg on two occasions.
(3) New York Heart Association functional class IV is the standard for severe heart failure.
(4) During the last six months, coronary revascularization.
(5) A recent acute myocardial infarction or recent unstable angina.
(6) Patients with coronary angiography contraindications.

All patients underwent thorough clinical examinations and history-taking procedures. The Al-Azhar University Faculty of Medicine's ethics and scientific committee granted its clearance.

2.1. Stress echocardiography

Beta-adrenergic blockers, calcium channel blockers, and long-acting nitrates had to be stopped by the subjects 48 h before the test. Standard views of baseline photographs were collected and documented.

The dose of dobutamine was started at 5 μg/kg/min and increased at 3 min intervals to 10, 20, 30, and 40 μg/kg/min. If the goal heart rate (i.e., 85% projected maximum) was not reached after the 40 mg/kg/min dosage, IV atropine (0.25–1.0 mg) was administered.

Patients were particularly asked about precordial discomfort, such as substernal heaviness and dull or agonizing pain, during DSE. These angina-like symptoms were often noted.

Infusion of dobutamine was stopped if any of the following occurred:

(1) Heart rate goal.
(2) novel anomaly in segmental wall motion.
(3) Complex supraventricular tachycardia or persistent ventricular ectopy.
(4) hypertension, defined as systolic blood pressure ≥220 mm Hg, or hypotension, defined as a ≥20 mmHg fall from baseline systolic blood pressure and absolute pressure of 90 mm Hg.
(5) Severe chest discomfort
(6) Disabling symptoms (e.g., dyspnea, nausea).

Images at baseline, 5 μg/kg/min, peak, and recovery were captured digitally and shown in quad loop format.

At baseline, a 12-lead electrocardiogram (ECG) was taken. Throughout the procedure, the ECG, blood pressure, and echocardiographic pictures were monitored.

A single cardiologist skilled in the interpretation of DSE investigations and blinded to clinical and angiographic results analyzed wall motion. The digitalized photos were interpreted, and the photographs were simply examined for clarification of ambiguous results.

As suggested by the American Society of Echocardiography, the left ventricle was separated into 16 parts for study. Based on systolic thickening and excursion, segments were categorized as follows: 1 = normal, 2 = hypokinetic, 3 = akinetic, and 4 = dyskinetic. Wall motion score index was determined by dividing the overall score (sum of segment grades) by the number of segments assessed.

Additional classifications for DSE studies included normal if no abnormalities were seen at baseline or peak stress and target heart rate was reached, abnormal if a wall motion anomaly was seen at baseline or developed at peak stress, and indeterminate if no anomalies were seen at baseline or peak stress and target heart rate was not reached.

2.2. Coronary angiography

Standard clinical procedures were used during the cardiac catheterization. With special attention paid to achieving acceptable opacification and visibility of the proximal and middle regions of each coronary artery without overlapping or distortion, several projections of the left and right coronary arteries were recorded. Pictures were captured. Without having knowledge of any clinical or DSE data, all videos were interpreted.[6]

Further classifications of stenosis include minor (20–49% constriction), moderate (50–69%), and severe (≥70%). Calculated was an angiography severity score that takes into account collateral

Table 1. PCA findings among included patients (n = 150).

Artery	Normal	<50% stenosis	50–70% stenosis	>70% stenosis
Normal coronary arteries	53 (35.3)			
Ectatic coronary arteries	30 (20)			
Left main artery	144 (96)	5 (3.3)	1 (0.7)	0
Left anterior descending artery	91 (60.7)	37 (24.7)	13 (8.7)	9 (6)
Diagonal artery	140 (93.3)	6 (4)	4 (2.7)	0
Left circumflex artery	114 (76)	22 (14.7)	8 (5.3)	6 (4)
Obtuse marginal artery (OM)	136 (90.7)	8 (5.3)	5 (3.3)	1 (0.7)
Right coronary artery	99 (66)	27 (18)	15 (10)	9 (6)
Described in terms of Frequency (percentage)				

existence, amount and location of stenosis, and % luminal. A severity score of 5.0 will be given to angiograms with just mild anomalies that reduce the lumen width ≥20%; higher values indicate an angiographic condition that is becoming more severe.

2.3. Statistical analysis

For data analysis, we utilized SPSS (statistical package of social sciences) software, version 24. When numerical data was not normally distributed, it was reported using the median and interquartile ranges instead of the mean and standard deviation. To examine the normality of the distribution of categorical variables, the Kolmogrov-Semornov test was performed. To investigate the relationship between categorical variables, the chi square test was used. In cases when the assumptions were broken, the fissure exact test was used. A parametric numerical variable difference between two groups was tested using an independent sample *t*-test. A *P* value of 0.05 or less was regarded as statistically meaningful.

3. Results

We enrolled 150 patients admitted to catheter unit in Cardiology Department at Al-Hussein University Hospitals between June 2021 to June 2022 with chest pain despite negative DSE Their mean age was 50.99 ± 8.29 years old. 56.7% of patients were males.

All patients underwent stress echocardiography. Despite their results were negative, concerning chest pain, we found that 26.7% of patients developed severe chest pain. All patients underwent diagnostic percutaneous coronary angiography (PCA) and found that:

35.3% of patients had normal coronary arteries on performing angiography. While 20% of included patients had ectacic coronary arteries on angiography. The left anterior descending (LAD) artery was the most common to be severely stenosed. This was prevalent among 6% of included patients. The obtuse marginal artery (OMA) was found to be severely stenosed in only one patient (0.7% of patients).

The right coronary artery was the commonest artery to be found moderately stenosed; which was prevalent among 10% of included patients. this was followed by the left anterior descending artery which was moderately stenosed among 8.7% of included patients. The left main artery was the least

Table 2. Chest pain and PCA findings association among included patients.

Artery	Non-severe chest pain (n = 110)	Severe chest pain (n = 40)	P value
Left main artery			
No stenosis	109 (99.1)	35 (87.5)	
<50% stenosis	1 (0.9)	4 (10)	0.005 F
50–70% stenosis	0	1 (2.5)	
>70% stenosis	0	0	
Left anterior descending artery (LAD)			
No stenosis	85 (77.3)	6 (15)	
<50% stenosis	23 (20.9)	14 (35)	<0.001 F
50–70% stenosis	2 (1.8)	11 (27.5)	
>70% stenosis	0	9 (22.5)	
Diagonal artery			
No stenosis	107 (97.3)	33 (82.5)	
<50% stenosis	2 (1.8)	4 (10)	0.009 F
50–70% stenosis	1 (0.9)	3 (7.5)	
>70% stenosis	0	0	
Left circumflex artery			
No stenosis	93 (84.5)	21 (52.5)	
<50% stenosis	12 (10.9)	10 (25)	<0.001 F
50–70% stenosis	2 (1.8)	6 (15)	
>70% stenosis	3 (2.7)	3 (7.5)	
Obtuse marginal artery			
No stenosis	103 (93.6)	33 (82.5)	
<50% stenosis	5 (4.5)	3 (7.5)	0.055 (F)
50–70% stenosis	2 (1.8)	3 (7.5)	
>70% stenosis	0	1 (2.5)	
Right coronary artery			
No stenosis	89 (80.9)	10 (25)	
<50% stenosis	16 (14.5)	11 (27.5)	<0.001 F
50–70% stenosis	5 (4.5)	10 (25)	
>70% stenosis	0	9 (22.5)	

found artery to be moderately stenosed in only one patient (0.7% of patients) Table 1.

We investigated the relationship between chest pain and angiographic data and discovered.

3.1. Concerning the left main artery

We found no marked stenosis in LM was recorded among patients wether with severe or non-severe chest pain. On the other hand, nearly all patients with nonsevere chest pain had normal LM. Although 2.5% of patients with severe chest pain had significant LM stenosis compared to no patients among those with non-severe chest pain, ($P = 0.005$).

Table 3. Chest pain and PCA degree of stenosis association among included patients.

Arterial state	Nonsevere chest pain ($n = 110$)	Severe chest pain ($n = 40$)	P value
Normal	79 (71.8)	4 (10)	
<50%	20 (18.2)	5 (12.5)	<0.001 F
50%–70%	8 (7.3)	11 (27.5)	
>70%	3 (2.7)	20 (50)	

F, Fissure exact test.

3.2. Concerning the left anterior descending artery

We found no marked stenosis was recorded in LAD artery among patients with nonsevere chest pain in comparison to 22.5% of patients with severe

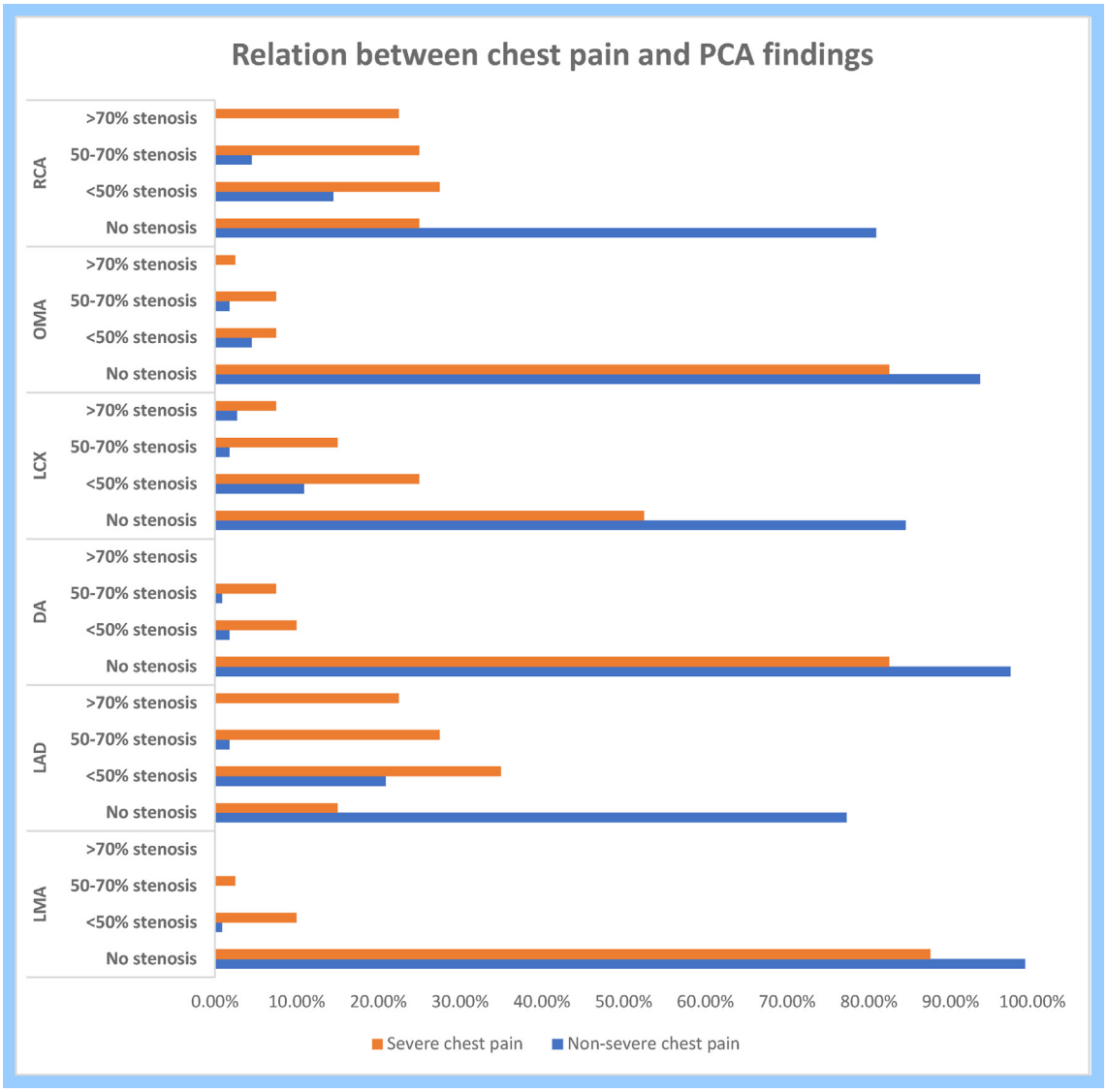

Fig. 1. Relation between developed chest pain and degree of stenosis among included patients.

chest pain (p patients). on the other hand, most patients among those with non-severe chest pain had normal LAD in comparison to 15% of patients with severe chest pain, ($P < 0.001$).

3.3. Concerning the diagonal artery

We found no marked stenosis in diagonal artery (DA) was recorded among patients wether with severe or non-severe chest pain. On the other hand, nearly all patients with non-severe chest pain had normal DA. Although 7.5% of patients with severe chest pain had moderate DA stenosis compared to 0.9% of patients with non-severe chest pain, ($P = 0.005$).

3.4. Concerning the left circumflex artery

We found that marked stenosis of left circumflex artery (LCX) was significantly more recorded among patients with severe chest pain compared to those with non-severe chest pain (7.5% vs 2.7%) of patients respectively. On the other hand, normal LCX was more significantly present among patients with non-severe chest pain compared to others (84.5% vs 52.5%) of patients respectively ($P < 0.001$).

3.5. Concerning the obtuse marginal artery

We found that marked stenosis of OMA was recorded in only one patient with severe chest pain. On the other hand, normal LCX was more slightly present among patients with non-severe chest pain compared to others (93.6% vs 82.5%) of patients respectively, ($P = 0.055$).

3.6. Concerning the right coronary artery

We found no marked stenosis in coronary artery (RCA) was recorded among patients wether with non-severe chest pain while, 22.5% of patients with severe chest pain had marked stenosis of RCA. In addition, 80.9% of patients with non-severe chest pain had normal RCA. While 25% of patients with severe chest pain had normal RCA compared to 80.9% of those with non-severe chest pain, ($P < 0.001$) Table 2, Fig. 1.

We found that there was a significant association between arterial stenosis found by PCA and developing chest pain ($P < 0.001$):

Marked stenosis was more significantly present among those with severe chest pain compared to others; 50% of patients who developed severe chest pain had marked coronary artery stenosis.

While, normal arteries were more likely to be found among those with non-severe chest pain when compared to others, ($P < 0.001$) Table 3, Fig. 2.

We also compared angiographic data between patients and found that:

There was no significant difference between both groups concerning age distribution ($P = 0.985$). similarly, no significant difference was recorded when comparing between both groups concerning gender distribution, ($P = 0.494$).

Similarly, no significant association between having positive family history and developing severe stenosis upon angiography ($P = 1.00$).

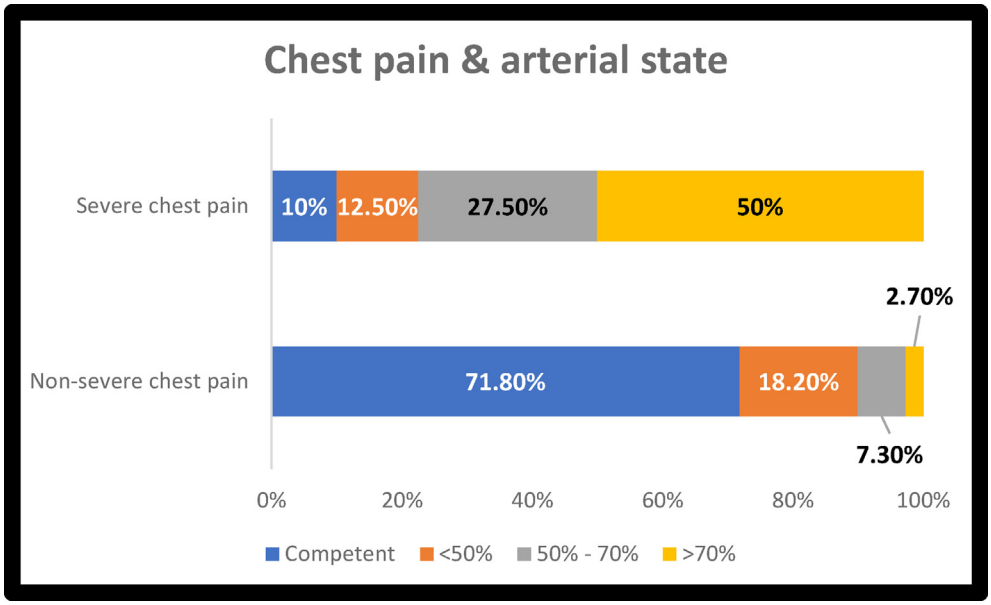

Fig. 2. Association between chest pain and PCA degree of stenosis among included patients.

Table 4. Relation between Diabetes and angiographic findings among included patients.

Arterial state	Diabetes only ($n = 8$)	Diabetes with other risk factors ($n = 29$)	P value
Normal	5 (62.5)	6 (20.7)	
<50%	2 (25)	6 (20.7)	<0.001 F
50%–70%	1 (12.5)	7 (24.1)	
>70%	0	10 (34.5)	

Fissure exact test.

Also found that 59.1% of patients who developed severe stenosis upon angiography compared to 52.8% of patients with non-severe stenosis were hypertensive, ($P = 0.648$).

Additionally, no significant association was found between developing dyslipidemia and having coronary stenosis in angiography ($P = 0.170$). while, 43.5% of patients who developed severe stenosis were diabetic. This was significantly more than the other group among whom only 25.4% of patients were diabetic, ($P = 0.034$) Table 4.

4. Discussion

Cardiovascular diseases (CVD) are widespread globally. One-third of worldwide deaths are from CVD. CAD is the most frequent CVD across all ages.[7] Clinical presentation varies from deadly myocardial infarction to nonfatal cardiomyopathy that worsens patients' life.[8] This is connected to atherosclerosis risk factors, including lipid accumulation on artery walls. Sampasa-Kanyinga estimated 70% of people had several CAD risk factors.[9]

CAD's financial impact has expanded due to additional prescription drugs, hospitalizations, and revascularizations. In 2010, CVD cost $863 million. By 2030, this might exceed $1 billion.[6] Noninvasive ways for detecting CAD have evolved. Stress echocardiography is a good tool for diagnosing ischemic myocardial disorders. It may be done via exercise or DSE.[10]

DSE is a noninvasive test for ischemic heart disease. Mid 1980s. European society of cardiology (ESC) recommended stress echocardiography for individuals with a 15% chance of CAD.[11]

DSE became widely used in diagnosing CAD and risk stratifying patients with unstable angina, valvular heart disease, acute and chronic myocardial infarction (MI). To stratify high-risk patients, DSE got increasingly sophisticated. With increasing dobutamine dosages or atropine, the stress regimen became aggressive.[5]

In Lee et al. study, 1608 individuals were recruited, chest discomfort was noted in 8.4% of cases.[12] In our study, we included all DSE induced chest pain patients. Invasive coronary angiography was used to identify coronary artery severity.

In our study, most patients had unaffected coronary arteries. Left anterior descending and right main coronary arteries were seriously damaged in 6% of individuals. Mild stenosis was seen in 24.7% of LAD arteries and 3.3% of left main artery arteries.

Our findings differed from Ezhumalai et al. who recruited 500 Indian patients undergoing PCI for suspected CAD. Only 23.8% of patients' angiography revealed no stenosis. This may be due to the patients' different genders. All patients were female, with majority being postmenopausal.[13] As known, Males in their reproductive years have a higher risk of CVD than females. Changes in sex hormones and body fat distribution increase the risk of CVD in postmenopausal women compared to men of the same age.[14]

Diabetes is closely linked with CAD. CAD helps determine diabetes patients' prognosis. Diabetic patients have a two-fold higher risk of cardiac death. 30% of US PCI patients are diabetic. in addition, One-quarter of CABG patients are diabetic. This was comparable to our research, where 24.7% of patients with chest discomfort were diabetic.[15]

Only one diabetic patient in our study had more than 50% stenosis of LCX. Diabetes did not impact the left major coronary artery or obtuse marginal artery. Similarly, LAD was most usually stenosed in diabetic patients.

Fernández et al. recruited 334 high-risk CAD patients from three tertiary care facilities between 2002 and 2008. They observed for 22.4 months for cardiac events (MACE). Distal vessels were impacted more in diabetics than non-diabetics. 59.6% of diabetics had left main artery disease.[16]

Kip et al. studied 281 diabetic patients for 2 years in a multi-center nationwide study. Diabetic individuals exhibited substantial coronary stenosis, notably in the LAD and LCX arteries.[17]

4.1. Conclusion

15.3% of patients with chest pain following DSE had significant coronary arteries stenosis on PCA. DM was associated with that stenosis. That is why, in patients with negative DSE and chest pain, further investigations are required. Special emphasis should be directed to patients with more than one risk factor including diabetes mellitus.

Conflict of interest

Payment/services info: All authors have declared that no financial support was received from any

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