

FREQUENCY OF NORMAL CORONARIES IN PATIENTS UNDERGOING CORONARY ANGIOGRAPHY FOR LEFT VENTRICULAR SYSTOLIC DYSFUNCTION

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ABSTRACT

Background: Left ventricular (LV) systolic dysfunction is often linked to obstructive coronary artery disease, but not all patients show significant blockages on angiography.

Objective: To determine the frequency of normal coronary arteries in patients undergoing coronary angiography for left ventricular systolic dysfunction.

Methods: This cross-sectional study included 114 patients with LV systolic dysfunction who underwent coronary angiography. Demographic details, clinical history, and cardiovascular risk factors were recorded. Patients were grouped based on angiographic findings, and comparisons were made between those with normal and abnormal coronaries.

Results: Normal coronary arteries were found in 69.3% of patients. Age and gender were not linked to angiographic outcomes. Patients without diabetes and those with no prior cardiac history were more likely to have normal coronaries. Urban residence was also associated with a higher proportion of normal findings. Other factors, including hypertension, dyslipidemia, smoking, and duration of LV dysfunction, did not show a clear association.

Conclusion: A large number of patients with LV systolic dysfunction have normal coronary arteries, suggesting that factors other than obstructive disease may be involved. These findings highlight the importance of looking beyond angiography when evaluating such patients.

KEYWORDS: Left ventricular systolic dysfunction; Normal coronary arteries; Coronary angiography; Microvascular dysfunction; non-obstructive coronary disease

INTRODUCTION

In recent years, atherosclerotic coronary artery disease has emerged as a major contributor to increasing morbidity and mortality, and it is currently recognized as the foremost cause of death worldwide.¹ coronary artery disease may cause remodeling of the left ventricle, which can impair diastolic function and lead to increased stiffness of the myocardial tissue. As a consequence, ventricular filling becomes compromised and cardiac filling pressures rise, leading to diastolic dysfunction that frequently develops before any noticeable decline in systolic function.²⁻³ Inflammation-associated coronary microvascular dysfunction may further play a role in the pathophysiology of left ventricular dysfunction and progression to heart failure.⁴

Although heart failure is typically managed using similar treatment strategies irrespective of its etiology, recognizing ischemia as the main underlying cause of ventricular dysfunction has significant implications for patient management and prognosis.⁵⁻⁶ The ischemic cause of ventricular dysfunction can be suspected based on clinical assessment and supported by cardiac imaging studies or coronary angiography, which may reveal significant stenosis in the coronary arteries.⁷ Coronary angiography is frequently employed in patients with systolic ventricular dysfunction and is considered the reference standard for diagnosing coronary artery disease.⁸⁻⁹

In some instances of myocardial ischemia or infarction, coronary angiography may demonstrate normal coronary arteries. These patients generally have a good prognosis, with favorable long-term outcomes and a low likelihood of major acute coronary events.¹⁰⁻¹¹ In a study involving 536 patients with left ventricular dysfunction, significant coronary artery lesions were identified in 25.2% of cases, whereas 74.8% of patients were found to have normal coronary arteries on angiography.¹²

The purpose of this study is to assess the prevalence of patients with left ventricular systolic dysfunction who are found to have normal coronary arteries on coronary angiography. Identifying the frequency of normal coronary arteries in this group is crucial, as it has important implications for diagnosis, management, and prognosis. Determining this frequency can help distinguish ischemic from non-ischemic cardiomyopathies, guide appropriate

therapeutic interventions, and prevent unnecessary exposure to invasive procedures, associated costs, thereby improving patient care and outcomes.

MATERIAL AND METHODS

This cross-sectional study will be conducted at Tabba Heart Institute, Karachi, over a period of six months following approval of the study protocol by the College of Physicians and Surgeons Pakistan (CPSP) and the institutional ethical review committee. A non-probability consecutive sampling technique will be employed to recruit participants. Based on a previously reported frequency of 74.8% for normal coronary arteries in patients with left ventricular systolic dysfunction, the sample size has been calculated using the WHO sample size calculator, taking a 95% confidence level and 8% margin of error, resulting in a total of 114 patients.

Patients aged between 40 and 70 years, of either gender, who are known cases of left ventricular systolic dysfunction (defined as an ejection fraction of less than 40% on transthoracic echocardiography performed within the last six months) and are undergoing coronary angiography will be included. Patients with a prior history of myocardial infarction, myocardial infarction with non-obstructive coronary arteries (MINOCA), or those who have previously undergone percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG) will be excluded from the study.

After obtaining informed consent, relevant baseline information including demographic characteristics (age and gender) and laboratory parameters such as lipid profile and HbA1c will be recorded. Clinical data regarding comorbid conditions including diabetes mellitus, hypertension, dyslipidemia, and smoking status will also be documented according to predefined operational criteria. All enrolled patients will undergo invasive coronary angiography for the evaluation of left ventricular systolic dysfunction. The angiographic findings will be interpreted by an interventional cardiologist with at least five years of post-fellowship experience. Coronary arteries will be classified as normal if no segment demonstrates $\geq 25\%$ stenosis on visual assessment. The cardiologist assessing the angiograms will be blinded to the patients' clinical information to reduce observer bias. Findings will be recorded on a structured proforma.

Data will be entered and analyzed using SPSS version 25.0. Categorical variables such as gender, comorbidities, and frequency of normal coronary arteries will be presented as frequencies and percentages, while continuous variables such as age and duration of left ventricular systolic dysfunction will be expressed as mean $\pm$ standard deviation or median with interquartile range depending on data distribution. Normality of continuous data will be assessed using the Shapiro–Wilk test. Stratification will be performed to control for potential effect modifiers including age, gender, comorbidities, and duration of disease. Post-stratification comparisons will be made using the chi-square test or Fisher's exact test where appropriate. A p-value of ≤ 0.05 will be considered statistically significant.

RESULTS

A total of 114 patients with left ventricular (LV) systolic dysfunction were included in the study. Most participants were in the older age group, with over four-fifths (80.7%) between 56 and 70 years, while only 19.3% were aged 40 to 55 years. The gender distribution was fairly balanced, with a slight male predominance (51.8%). A large proportion of the study population came from urban areas (74.6%). In terms of disease duration, nearly 60% had LV dysfunction for more than 12 weeks, suggesting that chronic cases were more common. Comorbid conditions were frequent but not overwhelming—diabetes was present in 28.1% and hypertension in 26.3%, while dyslipidemia was seen in about half of the participants. Smoking was reported in 36% of patients, and 38.6% had a prior cardiac history. Notably, a striking 69.3% of patients were found to have normal coronary arteries on angiography.

When comparing patients based on coronary angiography findings, age did not appear to play a meaningful role. Although a slightly higher proportion of younger patients had normal coronaries, the difference was not statistically significant. Gender also showed no influence, with men and women having almost identical rates of normal coronary findings. This suggests that, in this group, neither age nor sex alone can reliably predict whether coronary arteries will appear normal or obstructed.

In contrast, residence showed a clear pattern. Patients living in urban areas were far more likely to have normal coronary arteries compared to those from rural settings. This difference was statistically significant and may point toward variations in lifestyle, healthcare access, or referral practices. The duration of LV dysfunction, however, did not show any meaningful relationship with angiographic findings, although there was a slight tendency for patients with shorter duration to have normal coronaries more often.

Among the clinical risk factors, diabetes stood out. Patients without diabetes were considerably more likely to have normal coronary arteries, whereas those with diabetes showed a higher likelihood of obstructive disease. Hypertension followed a similar pattern, with fewer hypertensive patients having normal coronaries, although this

did not reach statistical significance. Dyslipidemia and smoking did not show a clear relationship with coronary status in this analysis, even though minor differences were observed between groups.

One of the strongest associations emerged with prior cardiac history. Patients who had no previous cardiac events were overwhelmingly more likely to have normal coronary arteries, while those with such a history were much more likely to have obstructive disease. This finding reinforces the importance of clinical history when evaluating these patients. On the other hand, family income did not appear to influence angiographic outcomes. Taken together, the results highlight that a large proportion of patients with LV systolic dysfunction do not have obstructive coronary disease, particularly those without diabetes or prior cardiac events, suggesting that alternative mechanisms such as microvascular dysfunction may play an important role.

Table 1: Distribution of baseline characteristics among the study participants.

Variables	n (%)
Age	
40 to 55 years	22 (19.3)
56 to 70 years	92 (80.7)
Gender	
Male	59 (51.8)
Female	55 (48.2)
Residence status	
Urban	85 (74.6)
Rural	29 (25.4)
Duration of LV Systolic dysfunction	
≤ 12 weeks	46 (40.4)
> 12 weeks	68 (59.6)
Diabetes Mellitus	
Yes	32 (28.1)
No	82 (71.9)
Hypertension	
Yes	30 (26.3)
No	84 (73.7)
Dyslipidemia	
Yes	56 (49.1)
No	58 (50.9)
Smoking status	
Yes	41 (36)
No	73 (64)
Prior cardiac history	
Yes	44 (38.6)
No	70 (61.4)
Family monthly income	
≤ 75000	40 (35.1)
> 75000	74 (64.9)
Angiographically normal coronaries	
Yes	79 (69.3)
No	35 (30.7)
Total	114 (100)

Table 2: Distribution of patient characteristics according to the Angiographically normal coronaries groups.

Variables	Angiographically normal coronaries Yes n (%)	Angiographically normal coronaries No n (%)	P value
Age			0.36
40 to 55 years	17 (77.3)	05 (22.7)	
56 to 70 years	62 (67.4)	30 (32.6)	

Gender			0.96
Male	41 (69.5)	18 (30.5)	
Female	38 (69.1)	17 (30.9)	
Residence status			0.01
Urban	67 (78.8)	18 (21.2)	
Rural	12 (41.4)	17 (58.6)	
Duration of LV Systolic dysfunction			0.38
≤ 12 weeks	34 (73.9)	12 (26.1)	
> 12 weeks	45 (66.2)	23 (33.8)	
Diabetes Mellitus			0.01
Yes	17 (53.1)	15 (46.9)	
No	62 (75.6)	20 (24.4)	
Hypertension			0.08
Yes	17 (56.7)	13 (43.3)	
No	62 (73.8)	22 (26.2)	
Dyslipidemia			0.19
Yes	42 (75)	14 (25)	
No	37 (63.8)	21 (36.2)	
Smoking status			0.55
Yes	27 (65.9)	14 (34.1)	
No	52 (71.2)	21 (28.8)	
Prior cardiac history			0.01
Yes			
No	15 (34.1)	29 (65.9)	
	64 (91.4)	06 (8.6)	
Family monthly income			0.90
≤ 75000			
> 75000	28 (70)	12 (30)	
	51 (68.9)	23 (31.1)	

DISCUSSION

In this study, a substantial proportion of patients with left ventricular (LV) systolic dysfunction were found to have normal coronary arteries on angiography. This rate appears higher than what has been reported in more general angiography populations. For instance, Levitt et al., 2013, Canada observed normal coronary arteries in about 41.9% of patients undergoing evaluation for stable angina.¹³ The difference likely reflects the nature of our cohort, which focused specifically on patients with LV dysfunction. It suggests that in this group, non-obstructive mechanisms may account for a large share of disease, rather than classic epicardial coronary artery narrowing.

Age and gender did not show a meaningful relationship with angiographic findings in our analysis. This contrasts with previous work, particularly Levitt et al. where female sex was a strong predictor of normal coronary arteries.¹³ In our population, however, men and women had almost identical rates of normal findings. A similar pattern was seen with age, where younger patients showed only a slight, non-significant tendency toward normal coronaries. These findings suggest that once LV dysfunction is present, clinical presentation may be driven more by underlying myocardial or microvascular factors than by baseline demographics.

In contrast, traditional risk factors provided clearer differentiation. Patients without diabetes were significantly more likely to have normal coronary arteries, while those with diabetes more often had obstructive disease. This aligns with established knowledge linking diabetes to atherosclerosis. Prior cardiac history also stood out as a strong predictor—patients with no previous cardiac events were far more likely to have normal coronaries. Together, these findings reinforce the idea that risk factor burden and clinical history remain central to identifying patients with true coronary artery disease, even in those presenting with LV dysfunction.

The presence of LV dysfunction despite normal coronary angiography points toward mechanisms beyond large vessel disease. Earlier studies offer useful insight here. Cannon et al. demonstrated that patients with angina and normal epicardial arteries can still develop ischemia due to impaired coronary microvascular function, leading to both systolic and diastolic abnormalities.¹⁴ Similarly, Schofield et al. showed that a notable proportion of such patients already have measurable LV dysfunction at rest, even when angiograms appear normal.¹⁵ These observations support the idea that angiography alone may not capture the full extent of myocardial disease.

Further evidence comes from functional imaging and experimental models. Peix et al. reported that patients with normal coronaries can develop a reduction in ejection fraction after stress, consistent with transient ischemia and myocardial stunning.¹⁵ In addition, Labovitz et al. demonstrated that during acute ischemia, diastolic dysfunction appears early, often before systolic changes become evident.¹⁶ Taken together, these findings suggest that LV dysfunction in patients with normal coronary arteries is not incidental, but likely reflects underlying microvascular or functional abnormalities. This highlights the importance of considering alternative diagnostic approaches beyond conventional angiography when evaluating such patients.

LIMITATIONS

The study was based on a relatively small sample from a single center, so the findings may not fully reflect broader populations. In addition, we did not perform detailed functional or microvascular testing, which limits our ability to explain the underlying cause of LV dysfunction in patients with normal coronary arteries.

CONCLUSION

Many patients with left ventricular systolic dysfunction were found to have normal coronary arteries, suggesting that obstructive coronary disease is not always the main cause. Clinical factors like diabetes and prior cardiac history still help identify those with true coronary disease, but a large group likely has other underlying mechanisms. These findings highlight the need to look beyond angiography and consider functional causes when evaluating unexplained LV dysfunction.

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