

Studying Angiographic Disease Patterns in Patients With Left Bundle Branch Block Undergoing Coronary Angiography

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Abstract

Objective: To observe the relationship between left bundle branch block (LBBB) and coronary artery disease (CAD) severity using the SYNTAX score and to evaluate the impact of CAD severity on left ventricular ejection fraction (LVEF) in patients undergoing coronary angiography.

Methods: A prospective, comparative, cross-sectional study was conducted at the Rawalpindi Institute of Cardiology. Patients with symptomatic LBBB, defined by European Society of Cardiology criteria, who underwent coronary angiography were included. Echocardiography was used to assess LVEF, dividing patients into two groups: Group A (LVEF <45%) and Group B (LVEF ≥45%). CAD severity was evaluated using the SYNTAX score, categorising patients into low (0–22), intermediate (23–32), and high (>32) groups. Statistical analysis was performed using SPSS version 24, with a p-value of <0.05 considered significant.

Results: A total of 140 patients were included (57% male, mean age 57.14 ± 10.42 years). Hypertension (60%) and multi-risk factors (50%) were predominant. Angiography revealed left anterior descending artery (LAD) involvement in 60% of patients. Group A exhibited significantly higher intermediate and high SYNTAX scores than Group B (p<0.001). Male patients and those with multiple risk factors were more likely to show abnormal angiographic findings (p<0.05). LAD involvement was notably higher in patients with high SYNTAX scores (p=0.002).

Conclusion: Patients with LBBB show a strong correlation with severe CAD and reduced LVEF, highlighting the need for routine coronary angiography in high-risk cases. The study emphasises the importance of addressing cardiovascular risks aggressively in this population to improve clinical outcomes.

Keywords: Angiography; Coronary Artery Disease; Hypertension; Left Bundle Branch Block; Risk Factors

Introduction

According to research, Left Bundle Branch Block (LBBB) is an important finding in ECG with a strong association with several cardiac diseases, including hypertension, coronary artery disease (CAD) and cardiomyopathies.¹ Also, it is suggested that it has a negative cardiovascular prognostic value,² particularly in the context of CAD.

Globally, cardiovascular diseases (CVDs) remain the leading cause of mortality, with ischemic heart disease (IHD) contributing to nearly half of the total CVD burden.³ In South Asia, which harbours nearly a quarter of the world's population, the burden of CVD has been rising significantly over the past three decades, with an increase of approximately 49.6% in prevalence and 30.3% in mortality from 1990 to 2019.⁴ The region also exhibits unique risk factor profiles, including early-onset CAD, high rates of metabolic syndrome, and suboptimal hypertension control, all of which contribute to an increased susceptibility to LBBB-related complications.⁴ These trends highlight the urgent need for improved diagnostic and therapeutic strategies, particularly in understanding the relationship between LBBB and CAD severity.

While it is the case that when LBBB is associated with comorbid, it denotes more of an adverse prognosis, there are instances when such patients do not present with structural heart diseases and

Contributions:

T.A.R, S.H, A.U.R, A.S, H.S.M, M.H.Y - Conception of study
- Experimentation/Study Conduction
T.A.R, S.H, A.U.R, A.S, H.S.M, M.H.Y - Analysis/Interpretation/Discussion
T.A.R, S.H, A.U.R, A.S, H.S.M, M.H.Y - Manuscript Writing
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can have LBBB. The study by Ikram et.al showed that acutely developed LBBB is not an isolated finding but rather an indicator of underlying heart disease, emphasizing its clinical significance¹.

In such patients, LBBB can reduce the accuracy of CAD detection, making diagnosis more challenging. In such patients, LBBB can reduce the accuracy of CAD detection, making diagnosis more challenging.⁵ In these situations, the best practice standard for assessing CAD is still coronary angiography. Coronary angiography is indicated in symptomatic patients, those with high-risk ECG changes, unexplained heart failure, or multiple cardiovascular risk factors. In LBBB, it remains essential for accurate diagnosis and timely intervention, given the limitations of non-invasive tests.⁶ It has been established that patients with LBBB tend to have a more severe form of CAD, resulting in poor outcomes and decreased left ventricular ejection fraction.² However, there is still very limited information about the level of CAD severity in LBBB patients in the context of the SYNTAX score. The SYNTAX score is a system that helps to classify the complexity and severity of CAD based on angiography. It includes evaluation based on location, extent of stenosis and anatomical complexity lesion. It categorises patients into low, intermediate, and high-risk groups based on the risk for adverse outcomes. It can help us formulate strategies of care, whether or not we need to revascularize and predict the prognosis of the patient.

The diagnostic criteria of LBBB have been recently revised by the European Society of Cardiology to help improve its specificity.^{6,7} However, due to its strictness, it has made the process a bit more complex. Although it may help refine the selection process for patients who qualify for treatments such as cardiac resynchronisation therapy (CRT), it now excludes more patients from receiving a diagnosis. Some of these patients, individuals who could have benefited from an earlier diagnosis as well as intervention, are now left to progress to a worse stage before receiving care. Thus, it is more important than ever to study the relationship of LBBB with CAD severity and LVEF.

Mutar et al. identified the left anterior descending artery (LAD) as the most commonly diseased vessel, along with compromised cardiac function, in patients with concurrent LBBB and CAD.⁸ However, no extensive work on these relationships has been found in our locality. Our study aimed to fill this particular gap. We aimed to evaluate the presence, intensity and pattern of CAD (using the SYNTAX score) in LBBB patients, as well as explore the impact on heart function.

Materials And Methods

A prospective comparative cross-sectional study was done from 15th June 2024 to 14th December 2024. The sample size was calculated using a study by Mutar et.al as a reference, and using the WHO calculator, it came out to be 140.⁸ LBBB was also measured against the severity of CAD concerning the SYNTAX score, and its effect on LVEF as well. Symptomatic LBBB (chest pain, dyspnea, palpitations, or unexplained fatigue) was checked in patients who presented to the emergency department or outpatient clinic at Rawalpindi Institute of Cardiology. We defined LBBB per the European Society of Cardiology guidelines.⁷ It was set as having a QRS duration of greater than 120 milliseconds with broad notched or slurred R waves in leads I, V5, and V6, and no Q waves on these leads. Patients with symptomatic LBBB who were subjected to coronary angiography and those with chest pain or symptoms indicating ischemic heart disease were included in the study. Those who are not experiencing symptoms due to LBBB or ongoing treatment, PCI or CABG cases, and those who have been cautioned against coronary intervention through contraindications such as acute heart failure or renal failure were excluded. Once written permission was given, demographic and medical information such as age, gender, and any comorbidities, such as dyslipidemia, diabetes mellitus and hypertension, were registered. A comprehensive assessment was carried out on every patient, which included:

1. Echocardiography: LVEF was evaluated using Simpson's approach. Patients were divided into two groups based on their LVEF. Group A had LVEF <45%, while Group B had LVEF ≥45%.

2. Coronary Angiography: It was done by an interventional cardiologist who has extensive experience performing procedures using standard practices. The examination of Angiographic data enabled the determination of the location of lesions and the severity of disease. To classify CAD severity into three groups, all patients were assessed with the SYNTAX score and classified as follows: Low (0-22), Intermediate (23-32), and High (>32).

Data was processed in SPSS version 24. For continuous variables, the mean standard deviation (SD) was used; for categorical variables, it was represented by frequencies and percentages. Using the chi-square test, we determined the relationship between categories of LVEF and SYNTAX scores. A P-value of 0.05 was considered statistically significant.

Results

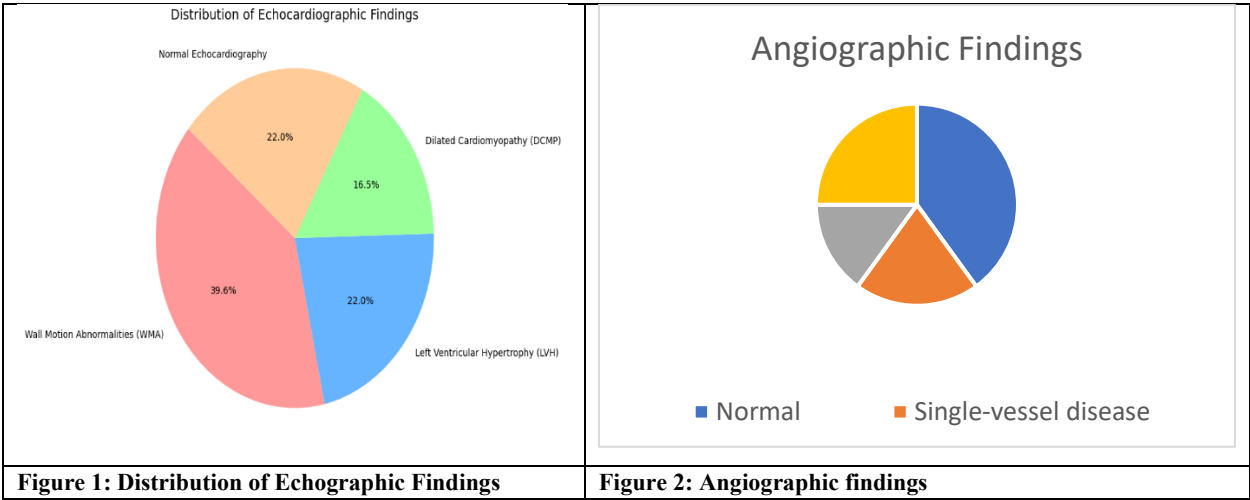
A total of 140 patients who satisfied the inclusion criteria were included in this study. 57% were male with an overall mean age of 57.14 (± 10.42). The majority (60%) of the patients exhibited hypertension as a risk factor, while half the participants exhibited two or more risk factors for CAD. The details of these characteristics can be found in Table 1.

Table 1: Demographic and Clinical Characteristics of the Study Population

Characteristic	Value
Mean Age (years)	57.14 (± 10.42) years
Gender Distribution	Male: 80 (57%), Female: 60 (43%)
Hypertension	84 (60%)
Diabetes Mellitus	49 (35%)
Smoking	63 (45%)
Dyslipidemia	35 (25%)
No Risk Factors	14 (10%)
Two or More Risk Factors	70 (50%)

Echocardiography put 43% (n=60) of the patients into Group A (EF<45%), while the rest were in Group B. Wall motion abnormalities were the most commonly observed issue, and they showed up in 36% of the patients, while 20 % of patients had no significant findings. The breakdown of these findings can be seen in Figure 1.

Angiography revealed the left anterior descending (LAD) to be the most commonly affected vessel. It was affected in 60 % of the patients, either alone or in combination. The breakdown of these findings can be seen in Figure 2. After calculating the SYNTAX scores for all the patients, they were divided into their respective groups, with 56 patients being in the low, 49 in the intermediate, and 35 in the high group, respectively.



A chi-square test was done, and it revealed some interesting observations. Firstly, male patients were significantly more likely to have CAD (p<0.05). Moving on, the relation between risk factors and angiographic findings was also significant (p<0.001). The more risk factors the patient had, the higher the incidence of abnormal angiographic findings. The breakdown of this relationship can be seen in Table 2.

Table 2: Distribution of Angiographic findings vs. number of risk factors

Risk Factor Group	Abnormal Angiography	Normal Angiography	p-value
No Risk Factors	4	11	<0.001
One Risk Factor	21	35	
Two or More Risk Factors	49	21	

The division of SYNTAX scores among the two groups was statistically significant (p<0.001). Group A had a higher prevalence of intermediate and high SYNTAX scores (15% and 18% respectively), while Group B had predominantly low scores. This distribution can be visualised in Figure 3.

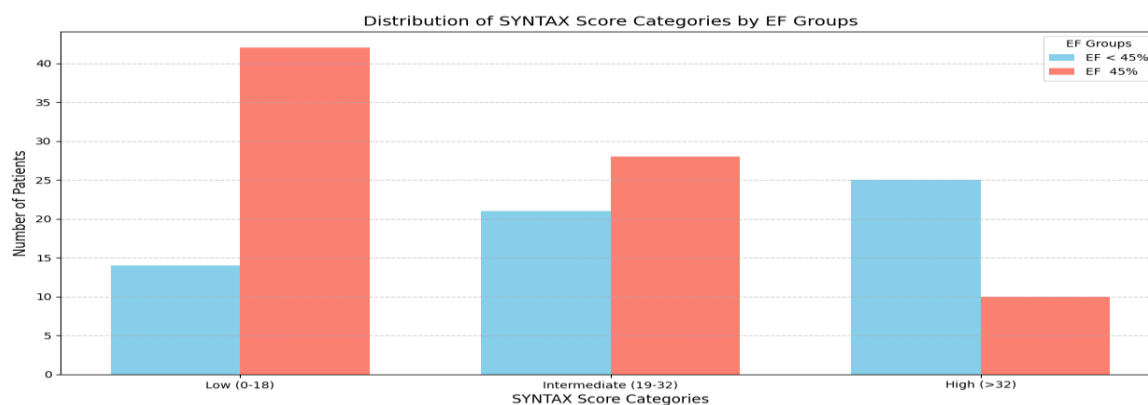


Figure 3: Distribution of SYNTAX score categories by EF groups

Table 3: Correlation of LAD involvement with SYNTAX scores.

SYNTAX Score Group	LAD Involvement	No LAD Involvement	p-value
Low (0–18)	28	28	0.002
Intermediate (19–32)	35	14	
High (>32)	21	14	

Discussion

The current research has contributed to providing insight into the relationship between left ventricular function, CAD severity, and LBBB. Its results suggest that multivessel CAD and LBBB have a strong relationship, especially in the left anterior descending artery. Other than this, the findings of this study indicate that LBBB and reduced left ventricular ejection fraction (LVEF) are correlated, leading to higher SYNTAX scores. This, in turn, indicates a more complicated coronary pathology. Our findings corroborate a study by Mutar et.al, which states that LAD is the most frequently affected vessel in LBBB patients undergoing angiography.⁶⁻⁸ Shehata et al. (2020) reported that LAD was the most frequently diseased vessel (61.3%) in LBBB patients, followed by the left circumflex (18.8%) and right coronary artery (17.5%). They also found a strong association between LBBB and left ventricular dysfunction, supporting our findings of reduced LVEF in high SYNTAX score patients. These results highlight the need for early coronary angiography in symptomatic LBBB cases.⁹

Interestingly, our findings reveal a notable LAD involvement even among patients with lower SYNTAX scores. This phenomenon may be explained by the fact that isolated proximal LAD disease or single-vessel involvement, despite its clinical significance, contributes to a lower SYNTAX score due to the scoring system's emphasis on lesion complexity rather than individual vessel importance. Additionally, patients with intermediate SYNTAX scores often have more extensive and complex multivessel disease, diluting the relative proportion of LAD involvement. These results align with prior studies indicating that despite a low SYNTAX score, LAD involvement remains clinically relevant, potentially influencing ischemic burden and left ventricular dysfunction.¹⁰ Given the prognostic implications of LAD disease, its presence should be carefully considered in clinical decision-making, irrespective of the overall SYNTAX score classification.

The study by Mutar et.al further highlights the negative effect of LBBB on left ventricular function, which is corroborated by our study, which shows a high prevalence of wall motion abnormalities (WMA) in our patients..⁸

Abnormal interventricular septum motion, characterised by a notable posterior movement, is the most common echocardiographic finding in LBBB patients.¹¹ The presence of WMA further emphasises the ischemic changes in these patients, as also evidenced by Bhardwaj et.al.¹² The majority of our patients had predominantly LAD involvement, consistent with the finding of Maggialelli et.al.¹³ Our results show a significant correlation between higher SYNTAX scores and reduced LVEF, indicating worsening myocardial dysfunction caused by conduction abnormalities, as highlighted by Xu et.al.¹⁴

The current research has also contributed to highlighting the difficulties associated with a diagnosis of CAD in patients suffering from LBBB. Invasive procedures, such as coronary angiography, are usually necessary for correct assessment. This is because non-invasive techniques, like nuclear imaging and stress echocardiography, often give false-positive results because of conduction abnormalities.¹⁵ The findings of this study highlight multiple insights from the clinical perspective. It highlights that an in-depth cardiovascular investigation is required of patients suffering from LBBB, through its results indicating a strong association between abnormal angiographic findings, multiple risk factors and high SYNTAX scores. Evidence emerging recently proves that LBBB predicts adverse cardiovascular outcomes, as well as increased CAD severity. LBBB has been linked with major adverse cardiovascular events and calls for aggressive management in patients.¹⁶ To guide in terms of therapeutic strategies

like revascularisation for these patients, especially those with multiple risk factors or reduced LVEF, routine coronary angiography is recommended. Patients with LBBB requiring intervention include those with high SYNTAX scores (>32), significantly reduced LVEF (<45%), extensive LAD involvement, and multiple cardiovascular risk factors. Given the limitations of non-invasive tests in LBBB, routine coronary angiography is recommended for high-risk individuals to guide timely revascularisation and improve outcomes. Intervention is required to improve outcomes, highlighted by the frequent involvement of LAD in high-risk patients. In terms of pathophysiology, CAD severity may worsen because of LBBB, through contraction and asynchronous ventricular depolarisation. This can further lead to ischemia and/or increased myocardial strain. In female patients, particularly, these observed associations may also be affected by systolic impairment and microvascular dysfunction.¹⁷ The current research has multiple limitations. The study is based on a small sample size and has a single-centre design. These factors indicate that the results may not be generalizable to a larger population. Other than this, a causal relationship between the variables has not been established, which is due to the cross-sectional nature of the research. Lastly, a selection bias may have also been made since LBBB patients were contraindicated for angiography, and those who were asymptomatic have been excluded. For the validation and long-term assessment of the findings, a longitudinal design and a multi-centre approach are required in the future. For providing deeper insights into the functional and structural cardiac abnormalities and their association with LBBB, the incorporation of advanced imaging modalities like cardiac magnetic resonance is recommended, since it can distinguish between non-ischemic and ischemic causes of LBBB with greater accuracy. Accurately distinguishing between these is of paramount importance, especially to tailor therapeutic strategies that are appropriate for each case, since LBBB may be associated with microvascular dysfunction, as well as myocardial fibrosis.¹⁸

Conclusions

This study highlights the strong association between LBBB and severe CAD, particularly with higher SYNTAX scores and reduced LVEF. Routine coronary angiography is essential for high-risk patients, given the frequent involvement of the LAD. While the findings provide valuable insights, their generalizability is limited by the study's small size and single-centre design, warranting further research with larger, multi-centre studies.

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