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Clinical, Echocardiographic and Angiographic Profile and Outcomes of Patients With Symptomatic Left Bundle Branch Block (LBBB): A Retrospective Observational Study From a Tertiary Care Center in Central India

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Research Article

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Abstract

Background:

Left bundle branch block (LBBB) is an important electrocardiographic abnormality frequently associated with structural heart disease, left ventricular dysfunction, and coronary artery disease (CAD). Data regarding the clinical profile, angiographic characteristics, and outcomes of symptomatic LBBB patients from Central India remain limited. This study aimed to evaluate the clinical, echocardiographic, and angiographic profile and six-month outcomes of symptomatic LBBB patients presenting to a tertiary care center.

Methods:

This retrospective observational study included 250 consecutive symptomatic patients with LBBB evaluated between March 2024 and March 2026 at a tertiary care center in Central India. Clinical characteristics, echocardiographic findings, coronary angiographic data, and six-month outcomes were analyzed. Associations between clinical variables and obstructive CAD were assessed using Chi-square and Fisher's exact tests, with odds ratios (OR) and 95% confidence intervals (CI) calculated where appropriate.

Results:

The mean age of the study population was 58.87 ± 10.27 years, and 52% were male. Hypertension (49%) and diabetes mellitus (34%) were the most common comorbidities. The mean QRS duration was 141.7 ± 15.8 ms, and the mean left ventricular ejection fraction (LVEF) was 34.3 ± 11.8%. Severe LV systolic dysfunction (LVEF < 30%) was present in 34% of patients. Obstructive CAD was identified in 98 patients (39%), non-obstructive CAD in 28 patients (11%), and normal coronary arteries in 124 patients (50%). The left anterior descending artery was the most frequently involved vessel (70%). Age ≥ 50 years ($p = 0.005$), angina ($p = 0.001$), diabetes mellitus ($p = 0.008$), and reduced LVEF ≤ 50% ($p = 0.006$) were significantly associated with obstructive CAD. During six-month follow-up, mortality occurred in 15 patients (6%). Obstructive CAD was associated with a significantly increased risk of mortality (OR 7.3; 95% CI 1.3–45.2; $p = 0.001$).

Conclusion:

Symptomatic LBBB is strongly associated with left ventricular systolic dysfunction, significant structural heart disease, and obstructive coronary artery disease. Advanced age, diabetes mellitus, angina, and reduced LVEF are important predictors of obstructive CAD. Early comprehensive evaluation with

echocardiography and coronary angiography may facilitate risk stratification and improve clinical outcomes in this high-risk population.

Highlights

• Obstructive coronary artery disease was identified in 39% of symptomatic patients with left bundle branch block.

• The left anterior descending artery was the most frequently involved coronary vessel, accounting for 70% of CAD cases.

• Age ≥50 years, diabetes mellitus, angina, and reduced left ventricular ejection fraction were significant predictors of obstructive coronary artery disease.

• Severe left ventricular systolic dysfunction was common, with 34% of patients demonstrating an LVEF below 30%.

• Patients with obstructive coronary artery disease had a 7.3-fold higher risk of mortality during six-month follow-up.

Introduction

Left Bundle Branch Block (LBBB) is a common electrocardiographic abnormality characterized by delayed ventricular depolarization, resulting in a widened QRS complex (≥ 120 ms) on electrocardiography.[1] Its presence frequently indicates underlying structural heart disease and is associated with increased cardiovascular morbidity and mortality.[2] LBBB may occur in diverse clinical settings including ischemic heart disease, cardiomyopathy, valvular heart disease, hypertension, or as an idiopathic conduction abnormality.[3]

The clinical presentation of patients with LBBB varies widely, ranging from asymptomatic individuals to those presenting with chest pain, dyspnoea, syncope, and palpitations.[3] A major diagnostic challenge arises in patients presenting with acute chest pain because LBBB may mask electrocardiographic features of acute myocardial infarction.[4] Therefore, comprehensive evaluation with echocardiography and coronary angiography is essential for risk stratification and therapeutic decision-making.

Echocardiography plays a pivotal role in assessing left ventricular (LV) systolic function, chamber dimensions, valvular abnormalities, and mechanical dyssynchrony in patients with LBBB. Previous studies have demonstrated that LBBB is strongly associated with LV systolic dysfunction, ventricular remodeling, and characteristic septal motion abnormalities.[5][6] These echocardiographic findings carry important prognostic implications.

Coronary angiography is commonly performed in symptomatic LBBB patients with suspected ischemic heart disease to determine the presence and extent of coronary artery disease (CAD). Previous

angiographic studies have shown variable prevalence of significant CAD among LBBB patients, emphasizing the heterogeneity of the underlying substrate.[7] Identification of coronary involvement patterns, especially left anterior descending artery (LAD) disease and multivessel involvement, is critical for guiding revascularization strategies and predicting outcomes.

This retrospective observational study aimed to evaluate the clinical, echocardiographic, and angiographic profile and six-month outcomes of symptomatic LBBB patients presenting to a tertiary care center in Central India. By analyzing these parameters, we sought to better understand the disease burden, predictors of obstructive coronary artery disease, and short-term outcomes in this regional population and compare our findings with existing literature.[1][3][7][8]

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Methodology

This retrospective observational study was conducted at a tertiary care center in Central India and included 250 patients with symptomatic Left Bundle Branch Block (LBBB). Clinical records, echocardiographic data, coronary angiography findings, and follow-up records of patients evaluated between March 2024 and March 2026 were reviewed. The study aimed to characterize the clinical, echocardiographic, and angiographic profiles, as well as six-month outcomes.

Ethics Statement

The study protocol was approved by the Institutional Ethics Committee; GOVT. MEDICAL COLLEGE, NAGPUR (Approval No: 3968; Approval Date: 05 May 2026). The study was conducted in accordance with the principles of the Declaration of Helsinki. Patient confidentiality was maintained throughout the study, and all data were analyzed anonymously.

Patient Population

A total of 250 symptomatic patients with LBBB identified from hospital records during the study period were included in the analysis. The mean age of the cohort was 58.87 ± 10.27 years, with an age range from 20 to 83 years. The cohort comprised 130 (52%) males and 120 (48%) females.

Clinical Evaluation

Baseline clinical data collected included presenting symptoms such as dyspnoea, angina, syncope, and palpitations. Comorbidities such as hypertension, diabetes mellitus, hypothyroidism, dyslipidemia, and other associated conditions were also recorded. Patients presenting with acute coronary syndrome (ACS), including NSTEMI and unstable angina (USA), were identified and documented.

Electrocardiographic Assessment

All patients had LBBB confirmed by electrocardiogram. QRS duration was measured in milliseconds, and electrocardiographic abnormalities were analyzed.

Echocardiographic Assessment

Echocardiography was performed to assess left ventricular ejection fraction (LVEF), categorized as normal (≥ 50%), mild dysfunction (40–49%), moderate dysfunction (30–39%), and severe dysfunction (< 30%). Additional parameters assessed included global left ventricular hypokinesia (GLVHK), regional wall motion abnormalities (RWMA), mitral regurgitation (MR), pulmonary hypertension (PH), aortic stenosis (AS), aortic regurgitation (AR), left ventricular end-diastolic diameter (LVEDD), and left ventricular end-systolic diameter (LVESD).

Angiographic Assessment

Coronary angiography was performed in all patients to evaluate for coronary artery disease (CAD). The study assessed arterial access route, coronary dominance pattern, obstructive and non-obstructive CAD, and vessel involvement including the left main coronary artery (LMCA), left anterior descending artery (LAD), right coronary artery (RCA), and left circumflex artery (LCx). In patients with obstructive CAD, lesion severity, diffuse or focal disease pattern, calcification, chronic total occlusion (CTO), and number of vessels involved were documented.

Follow-up and Outcomes

Follow-up information was obtained from outpatient records, hospital records, and available follow-up documentation. Outcomes assessed included mortality and major adverse cardiac events (MACE) within six months of presentation. Causes of death, associated comorbidities, LVEF status, coronary anatomy, and treatment strategy were analyzed.

Statistical Analysis

Statistical analysis was performed to evaluate associations between clinical, echocardiographic, and angiographic variables with obstructive CAD and mortality outcomes. Fisher's exact test and Chi-square test were used for categorical variables. Odds ratios (OR) with 95% confidence intervals (CI) were calculated. A p-value < 0.05 was considered statistically significant.

Results

A total of 250 patients with LBBB and cardiac symptoms who met the eligibility criteria were identified from hospital records and included in the analysis. The mean age of the study population was 58.87 ± 10.27 years (range: 20–83 years). Notably, 208 patients (83%) were aged 50 years or older. The cohort included 130 males (52%) and 120 females (48%).

Hypertension (123 patients; 49%) and diabetes mellitus (85 patients; 34%) were the most frequently observed comorbidities. The baseline characteristics are summarized in Table 1.

Table 1
Baseline characteristics of the study population (N = 250)

Variables	Values
Age, years, mean ± SD	58.87 ± 10.27
Sex, n (%)	
Female	120 (48)
Male	130 (52)
Comorbidities, n (%)	
Hypertension	123 (49)
Diabetes mellitus	85 (34)
Hypothyroidism	28 (11)
Dyslipidemia	28 (11)
Others	48 (19)
Presenting complaints, n (%)	
Dyspnoea	183 (73)
Angina	128 (51)
Syncope	20 (8)
Palpitations	13 (5)
ACS, n (%)	
NSTEMI	18 (7)
USA	25 (10)
ECG parameters, mean ± SD	
QRS duration, milliseconds	141.7 ± 15.8
Echocardiographic parameters	
LVEF, % mean ± SD	34.3 ± 11.8
Normal (≥ 50%), n (%)	50 (20)
Mild dysfunction (40–49%), n (%)	28 (11)
Moderate dysfunction (30–39%), n (%)	88 (35)
Severe dysfunction (< 30%), n (%)	85 (34)
GLVHK, n (%)	130 (52)

Variables	Values
RWMA, n (%)	78 (31)
Mitral regurgitation, n (%)	128 (51)
PH, n (%)	33 (13)
AS, n (%)	5 (2)
AR, n (%)	15 (6)
LVEDD, mm, mean ± SD	51.3 ± 7.3
LVESD, mm, mean ± SD	41.9 ± 11.23

The mean QRS duration among the study population was 141.7 ± 15.8 ms. The mean LVEF was 34.3 ± 11.8%. Severe LV systolic dysfunction, defined as an LVEF below 30%, was observed in 85 patients (34%), while only 50 patients (20%) had preserved LV systolic function. Moderate LV systolic dysfunction was noted in 88 patients (35%), indicating that the majority of patients had impaired LV function. Regional wall motion abnormalities (RWMA) were detected in 78 patients (31%), and global left ventricular hypokinesia (GLVHK) was present in 130 patients (52%). Mitral regurgitation was identified in 128 patients (51%) of the study cohort. The mean LVEDD was 51.3 ± 7.3 mm, and the mean LVESD was 41.9 ± 11.23 mm.

Angiographic Profile of the Study Population

Coronary angiography data were available for all included patients. Femoral access was utilized in 220 cases (88%), whereas radial access was used in 30 cases (12%). Right-dominant coronary circulation was observed in 178 patients (71%).

Among the 250 patients evaluated, coronary angiography revealed obstructive CAD in 98 patients (39%), non-obstructive CAD in 28 patients (11%), while 124 patients (50%) had normal coronary arteries. Among patients with CAD, the LAD artery was the most commonly involved vessel, affected in 88 patients (70%), followed by the RCA in 75 patients (60%), LCx in 58 patients (46%), and LMCA involvement in 8 patients (6%) (Table 2).

Table 2
Angiographic profile of the study population (N = 250)

Variables	Values
Access, n (%)	
Femoral	220 (88)
Radial	30 (12)
Dominance, n (%)	
Right	178 (71)
Left	40 (16)
Co-dominant	32 (13)
Pattern of CAD, n (%)	
Obstructive CAD (≥ 50% stenosis)	98 (39)
Non-obstructive CAD (< 50% stenosis)	28 (11)
Normal coronaries	124 (50)
Pattern of Vessel Involvement, n (%)	
LMCA	8 (6)
LAD	88 (70)
RCA	75 (60)
LCx	58 (46)

Pattern of Coronary Vessel Involvement in Obstructive CAD Patients

Among the 98 patients diagnosed with obstructive CAD, 8 patients (7.7%) had moderate stenosis (50–69%), whereas the majority, 90 patients (92.3%), had severe obstruction (≥ 70%). Diffuse coronary disease was observed in 60 patients (61.5%), while focal disease was present in 38 patients (38.5%). Coronary calcification was noted in 15 patients (15.4%), and chronic total occlusion (CTO) was identified in 5 patients (5.1%).

Regarding the extent of vessel involvement, single-vessel disease (SVD) was the most common pattern, observed in 40 patients (41.0%), followed by triple-vessel disease (TVD) in 28 patients (28.2%), double-vessel disease (DVD) in 23 patients (23.1%), and LMCA with TVD in 8 patients (7.7%). The LAD artery remained the most frequently affected vessel, involved in 75 patients (76.9%), followed by RCA involvement in 63 patients (64.1%), LCx involvement in 53 patients (53.8%), and LMCA involvement in 8 patients (7.7%) (Table 3).

Table 3
Pattern of coronary vessel involvement in obstructive CAD patients (n = 98)

Variables	Values
Severity of the lesion, n (%)	
Moderate obstruction (50–69%)	8 (7.7)
Severe obstruction (≥ 70%)	90 (92.3)
Pattern of the disease, n (%)	
Diffuse	60 (61.5)
Focal	38 (38.5)
Calcification, n (%)	15 (15.4)
CTO, n (%)	5 (5.1)
Number of vessels involved, n (%)	
LM-TVD	8 (7.7)
TVD	28 (28.2)
DVD	23 (23.1)
SVD	40 (41.0)
Type of vessel involved, n (%)	
LMCA	8 (7.7)
LAD	75 (76.9)
RCA	63 (64.1)
LCx	53 (53.8)

Association Between Clinical Variables and Obstructive CAD

Patients aged ≥ 50 years exhibited a significantly higher incidence of obstructive CAD (p = 0.005). Similarly, the presence of angina (p = 0.001), diabetes mellitus (p = 0.008), and reduced LVEF ≤ 50% (p = 0.006) demonstrated significant associations with obstructive CAD.

The odds of developing obstructive CAD were approximately 3.1 times higher in patients aged ≥ 50 years, 4.2 times higher among patients presenting with angina, 4.1 times higher among diabetic patients, and 3.3 times higher in patients with reduced LVEF compared with their counterparts without these risk factors (Table 4).

Table 4
Association of clinical variables with obstructive CAD

Variables	CAD (n = 98)	No CAD (n = 152)	P-value	Odds ratio (95% CI)
Age, years				
	8 (7.5%)	35 (22.9%)	0.005*	1.0 (Reference)
≥ 50	90 (92.3%)	117 (77.1%)		3.1 (1.1, 9.1)
Angina				
Absent	30 (30.8%)	122 (80.3%)	0.001*	1.0 (Reference)
Present	68 (69.2%)	30 (19.7%)		4.2 (1.8, 10.3)
Diabetes mellitus				
No	50 (51.3%)	115 (75.4%)	0.008*	1.0 (Reference)
Yes	48 (48.7%)	37 (24.6%)		4.1 (1.0, 9.34)
LVEF				
> 50%	10 (10.3%)	40 (26.2%)	0.006*	1.0 (Reference)
≤ 50%	88 (89.7%)	112 (73.8%)		3.3 (1.3, 7.1)

Association Between Obstructive CAD and Mortality

Mortality was significantly higher among patients with obstructive CAD (p = 0.001). Patients with obstructive CAD had a 7.3-fold increased risk of death compared with patients without CAD (OR 7.3; 95% CI: 1.3–45.2) (Table 5).

Table 5
Association between obstructive CAD and death as the outcome

Variable	Death Yes (n = 15)	Death No (n = 235)	P-value	Odds ratio (95% CI)
CAD				
No	3 (16.7%)	150 (63.8%)	0.001*	1.0 (Reference)
Yes	12 (83.3%)	85 (36.2%)		7.3 (1.3, 45.2)

Follow-up and Outcomes

Follow-up information was available for all 250 patients for a period of six months. During follow-up, 15 patients (6%) died. All deceased patients were older than 70 years of age, including 10 males and 5 females.

The causes of death included acute coronary syndrome (ACS) in five patients, acute decompensated heart failure (ADHF) in five patients, sudden cardiac death (SCD) in three patients, and refractory ventricular tachycardia (VT) in two patients. The overall six-month survival rate was 94%.

Among patients who died, 50% had both diabetes mellitus and hypertension, and all had an LVEF < 40%. Of the 15 deaths, 12 patients had obstructive CAD while three had non-obstructive CAD. Among the obstructive CAD group, LAD involvement was universally present. Five patients had isolated LAD disease, three had LMCA-TVD, three had DVD, and one patient had TVD. Only three patients underwent PCI, three were referred for CABG, while the remaining patients were managed with guideline-directed medical therapy (GDMT).

Discussion

This retrospective observational study provides a comprehensive evaluation of the clinical, echocardiographic, angiographic, and outcome profiles of symptomatic LBBB patients from a tertiary care center in Central India. The present study, involving 250 patients, represents one of the larger contemporary datasets evaluating symptomatic LBBB in the Indian population.

Demographic and Clinical Characteristics

The mean age of the study population was 58.87 ± 10.27 years, with 83% of patients aged ≥ 50 years, highlighting the strong association of LBBB with advancing age and degenerative cardiovascular disease. This observation is consistent with previous studies demonstrating an increasing prevalence of LBBB with advancing age due to progressive conduction system fibrosis and underlying structural heart disease.[3,8]

Unlike some previous studies reporting marked male predominance, our cohort demonstrated near-equal sex distribution with a slight male predominance (52% males vs 48% females). Similar demographic findings have been reported in contemporary studies evaluating symptomatic LBBB populations.[1,8]

Hypertension (49%) and diabetes mellitus (34%) were the most prevalent comorbidities, reinforcing the established relationship between metabolic and hypertensive cardiovascular disease and conduction abnormalities.

Dyspnoea (73%) and angina (51%) were the predominant presenting symptoms, reflecting the significant burden of heart failure and ischemic heart disease in symptomatic LBBB patients. Similar symptom profiles have been reported in previous observational studies, where symptomatic LBBB was strongly associated with underlying myocardial dysfunction and ischemia.[1]

Electrocardiographic and Echocardiographic Findings

The mean QRS duration in our study was 141.7 ± 15.8 ms, indicating advanced intraventricular conduction delay. Prolonged QRS duration in LBBB has been associated with increased electrical and mechanical dyssynchrony, progressive ventricular remodeling, and adverse cardiovascular outcomes.[5,11]

Echocardiographic evaluation revealed a substantial burden of LV dysfunction. The mean LVEF was 34.3 ± 11.8%, and nearly 80% of patients demonstrated varying degrees of LV systolic dysfunction. Severe LV dysfunction (LVEF < 30%) was present in 34% of patients, emphasizing the close association between LBBB and impaired ventricular mechanics. Similar observations have been reported previously in patients with LBBB-associated ventricular dysfunction.[2,9,12]

Global left ventricular hypokinesia (52%) and regional wall motion abnormalities (31%) were frequently observed, indicating both diffuse myocardial dysfunction and ischemic substrate. Mitral regurgitation was identified in 51% of patients, likely secondary to LV remodeling and papillary muscle dyssynchrony. These findings are consistent with previous echocardiographic studies.[6,10,13]

The mean LVEDD and LVESD values further demonstrated significant ventricular remodeling in this cohort, supporting the concept that chronic electrical dyssynchrony contributes to progressive structural cardiac changes.[11,12]

Mortality and Clinical Outcomes

During six-month follow-up, mortality was observed in 15 patients (6%). All deaths occurred in patients older than 70 years, highlighting the prognostic significance of advanced age.

Acute coronary syndrome and acute decompensated heart failure were the leading causes of death, followed by sudden cardiac death and refractory ventricular tachycardia, emphasizing the adverse cardiovascular profile associated with symptomatic LBBB and advanced structural heart disease.

Importantly, obstructive CAD was strongly associated with mortality, with affected patients demonstrating a 7.3-fold increased risk of death. Furthermore, all deceased patients had LVEF < 40%, underscoring the prognostic importance of LV systolic dysfunction.

The universal involvement of the LAD artery among deceased patients with obstructive CAD further highlights the critical role of extensive myocardial ischemia in determining adverse outcomes.

Diabetes mellitus and hypertension were highly prevalent among deceased patients, suggesting a synergistic contribution of metabolic and vascular risk factors to mortality. Although some patients underwent PCI or were referred for CABG, a substantial proportion were managed conservatively with guideline-directed medical therapy, likely reflecting advanced disease severity, frailty, or delayed presentation.

These findings are consistent with previous studies demonstrating increased mortality and adverse cardiovascular outcomes among patients with LBBB, particularly those with concomitant heart failure

and coronary artery disease.[18,19]

Recent reports published in the Anatolian Journal of Cardiology have highlighted the prognostic significance of coronary thrombotic burden, cardiovascular imaging parameters, and novel biomarkers in identifying patients at increased risk of adverse cardiovascular outcomes.[20–22]

Conclusion

Symptomatic LBBB is strongly associated with significant structural heart disease, left ventricular systolic dysfunction, and obstructive coronary artery disease. The present study demonstrates that elderly patients with diabetes mellitus, angina, and reduced LVEF are at particularly high risk for obstructive CAD and adverse outcomes.

LAD involvement and multivessel disease were common angiographic findings and were associated with increased mortality. Early comprehensive evaluation with echocardiography and coronary angiography is essential for timely risk stratification and optimization of management in symptomatic LBBB patients.

Abbreviations

ACS
acute coronary syndrome
CABG
coronary artery bypass grafting
CAD
coronary artery disease
CAG
coronary angiography
CTO
chronic total occlusion
DVD
double-vessel disease
GDMT
guideline-directed medical therapy
LAD
left anterior descending artery
LCx
left circumflex artery
LBBB
left bundle branch block
LMCA
left main coronary artery

LVEF
left ventricular ejection fraction
LVEDD
left ventricular end-diastolic diameter
LVESD
left ventricular end-systolic diameter
MACE
major adverse cardiac events
PCI
percutaneous coronary intervention
RCA
right coronary artery
RWMA
regional wall motion abnormality
SVD
single-vessel disease
TVD
triple-vessel disease.

Declarations

Ethics approval and consent to participate

This retrospective observational study was approved by the **Institutional Ethics Committee, Government Medical College, Nagpur, Maharashtra, India**. The requirement for individual informed consent to participate was waived by the ethics committee in accordance with institutional policy.

Consent for publication

Not applicable. No individually identifiable participant information or images are included in this manuscript.

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available because they contain clinical information and are subject to institutional and ethical restrictions. De-identified data may be available from the corresponding author on reasonable request, subject to approval by the Institutional Ethics Committee and the relevant institutional authorities.

Competing Interests

The authors declare that they have no competing interests.

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Authors 'contributions

Varun Mohod: Conceptualization, data collection, data analysis, literature review, manuscript drafting and final approval.

Rupesh Agrawal: Data interpretation, critical revision of the manuscript and final approval.

Sunil Washimkar: Clinical supervision, critical revision of the manuscript and final approval.

All authors read and approved the final manuscript.

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Conflict of Interest

The authors declare that they have no conflicts of interest relevant to this study.

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Clinical trial number

Not applicable.

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