***Original Research Article***

***Clinical and Echocardiographic Characterization of Structural Heart Disease in Patients with Left Bundle Branch Block***

**ABSTRACT**

**Background:**  
Left bundle branch block (LBBB) is a notable electrocardiographic finding often associated with underlying structural heart disease (SHD). It may signify the presence of myocardial or valvular pathology, cardiomyopathy, or coronary artery disease (CAD). This study aimed to evaluate the prevalence of SHD among patients with LBBB and to compare the clinical and echocardiographic profiles between those with and without SHD.

**Study Design**: Retrospective Observational Study

**Place and Duration of study:** Department of Cardiology, KIMSHEALTH, Trivandrum, from January 2019 and January 2024.

**Methods:**  
We retrospectively analyzed 159 patients diagnosed with LBBB, including 96 males and 63 females, with a mean age of 67 ± 10 years. Clinical data were collected regarding the presence of hypertension, diabetes, and symptoms such as chest pain. Echocardiographic assessments were used to evaluate left ventricular systolic function and dimensions. Patients were divided into two groups: SHD and No SHD. Statistical analyses were conducted to identify significant differences in clinical and echocardiographic characteristics between groups. Approval for the study was obtained from the institutional ethics committee.

**Results:**  
Of the 159 patients, 72.3% had evidence of SHD. A significantly higher proportion of males were observed in the SHD group compared to the No SHD group (64.3% vs. 40.9%, p = 0.006). Chest pain was more common in the SHD group (53.9% vs. 29.5%, p = 0.002), and a higher New York Heart Association (NYHA) functional class indicated poorer functional capacity (p < 0.001). Echocardiographic findings showed a lower mean ejection fraction (44.0 ± 8.0 vs. 61.7 ± 10.0, p < 0.001) and significantly larger left ventricular internal dimensions in diastole and systole in the SHD group. Among patients undergoing coronary angiography, the left anterior descending artery (LAD) was most frequently affected in single-vessel disease (49.1%), followed by the LCX (28.07%), RCA (17.54%), and LMCA (5.2%).

**Conclusion:**  
LBBB is frequently associated with SHD, and its presence should prompt detailed cardiac evaluation. Marked differences in clinical symptoms and echocardiographic parameters support LBBB as a significant marker of underlying cardiac pathology.

**Keywords**

*Coronary Artery Disease, Echocardiography, Functional Capacity, Left Bundle Branch Block, Structural Heart Disease.*

1. **INTRODUCTION**

Left bundle branch block (LBBB) is an electrocardiographic abnormality increasingly recognized for its significant implications for cardiovascular health. While historically viewed as a mere conduction disturbance, accumulating evidence suggests that LBBB often indicates underlying structural heart disease (SHD), including valvular pathology, cardiomyopathy, and coronary artery disease (CAD)1,2.

Despite the established association between LBBB and various cardiovascular conditions, a comprehensive understanding of the clinical characteristics and functional implications within specific patient populations remains limited. Studies have shown that LBBB is more prevalent among males and is frequently linked to significant cardiac comorbidities1,2. Furthermore, LBBB may play a causative role in the development of dilated cardiomyopathy and heart failure. However, the extent to which these associations manifest in diverse cohorts, particularly concerning functional capacity and echocardiographic findings, warrants further investigation1.

This study aims to elucidate the clinical and echocardiographic characteristics of patients diagnosed with LBBB, focusing on SHD. We intend to identify critical differences between those with and without SHD, enhancing our understanding of how LBBB may serve as an indicator of underlying cardiac dysfunction.

1. **METHODS**

This observational, retrospective study involved the analysis of ECGs with LBBB from hospitalized and ambulatory patients at our tertiary care institute between January 2019 and January 2024. Patients over 18 years of age who had their TTE performed at an interval no longer than 6 months from the diagnostic ECG were included. Those who developed LBBB during an acute coronary syndrome or within 24 hrs before death were excluded.

The medical records of the included patients were reviewed to assess cardiovascular risk factors and past medical history.

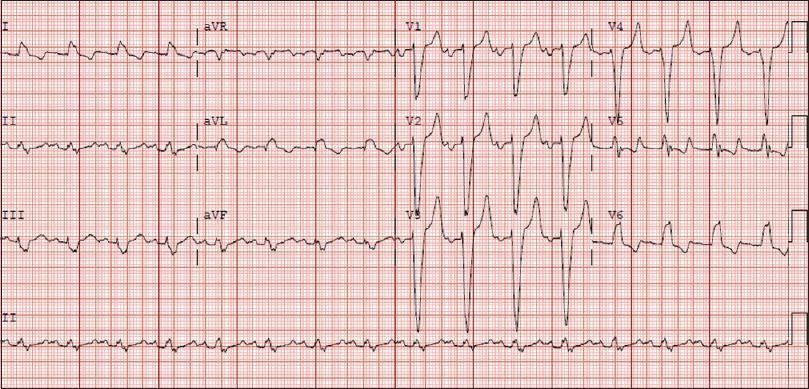
The echocardiographic parameters that were surveyed include- Ejection fraction(normal-50-70%), Left ventricular internal diameter at end-diastole (normal- 3.5–5.6 cm), Left ventricular internal diameter at end-systole (normal- 2.0–4.0 cm) and MR grade.

The ECG variables that were analysed were QRS duration, QRS axis and the criterion described in the literature for the diagnosis of LBBB.

The diagnostic criteria for the inclusion of LBBB were:

1. QRS duration greater than or equal to 120 ms in adults.
2. Broad notched or slurred R wave in leads I, aVL, V5, and V6and an occasional RS pattern in V5and V6 attributed to displaced transition of QRS complex.
3. Absent q waves in leads I, V5, and V6, but in the lead aVL.
4. R peak time greater than 60 ms in leads V5 and V6 but normal in leads V1, V2, and V3, when small initial r waves can be discerned in the above leads3.

Figure 1: **Diagnostic Criteria for LBBB**



These parameters were assessed along with their demographic characteristics, comorbidities and coronary angiographic patterns.

**2.1 Statistical analysis**

The data were analysed using IBM SPSS, version 24. A P value less than 0.05 was considered significant. Continuous data were expressed as mean (± standard deviation) and differences were compared with Student’s t test. Categorical data were expressed as percentages and numbers, and were compared using the Chi square test.

1. **RESULTS AND DISCUSSIONS**

In our sample of 159 patients meeting the criteria for LBBB, 96 were male and 63 were female, with a mean age of 67 ± 10 years. Among these patients, 127 (79.8%) had hypertension and 111 (69.8%) were diabetic. 115 (72.3%) were classified as having structural heart disease (SHD) and 44 (27.7%) as not having SHD (No SHD). *Table 1* summarizes the clinical and echocardiographic characteristics of the two groups.

There was no significant difference in age between the groups (SHD: 66.5 ± 9.8 years vs. No SHD: 67.2 ± 10.1 years; p = 0.691). However, the SHD group had a significantly higher proportion of males (74 [64.3%]) compared to the No SHD group (18 [40.9%], p = 0.006).

With respect to clinical symptoms, chest pain was reported by 62 (53.9%) patients with SHD versus 13 (29.5%) without SHD (p = 0.002), while the frequency of syncope did not differ significantly between the groups (9 [7.8%] vs. 2 [4.5%], p = 0.469). A history of myocardial infarction was markedly more common in the SHD group, with old MI present in 78 (67.8%) patients compared to 10 (22.7%) in the No SHD group (p < 0.001).

Functional capacity, as assessed by the New York Heart Association (NYHA) classification (on a scale from 1 to 4), was significantly impaired in patients with SHD. A detailed breakdown revealed that in the SHD group, 29 patients (25.2%) were in Class I, 29 (25.2%) in Class II, 45 (39.1%) in Class III, and 12 (10.4%) in Class IV, whereas the majority of the No SHD group were in Class I (32 [72.7%]), with fewer patients in Class II (9 [20.4%]) and Class III (3 [6.8%]), and none in Class IV(p<0.001).

The prevalence of diabetes mellitus (80 [69.6%] vs. 31 [70.5%], p = 0.784), hypertension (88 [76.5%] vs. 37 [84.1%], p = 0.949), and smoking (53 [46.1%] vs. 18 [40.9%], p = 0.124) were similar between the groups. Although serum creatinine tended to be higher in the SHD group (1.19 ± 0.35 mg/dL vs. 0.91 ± 0.30 mg/dL), this difference approached but did not reach statistical significance (p = 0.058).

Echocardiography revealed that patients with SHD had significantly impaired left ventricular function. The mean ejection fraction was markedly lower in the SHD group (44.0 ± 8.0% versus 61.7 ± 10.0%, p < 0.001). Additionally, left ventricular dimensions were significantly increased among SHD patients: LVIDd measured 5.39 ± 0.70 cm versus 4.60 ± 0.65 cm (p < 0.001) and LVIDs was 4.05 ± 0.80 cm compared to 3.00 ± 0.75 cm (p < 0.001).

Mitral regurgitation was also more prevalent in the SHD group, with 26 (22.6%) patients demonstrating MR grade of 3 or more compared to 4 (9.1%) in the No SHD group (p < 0.001). Reduced ejection fraction (EF < 40%) was observed in 44 (38.3%) SHD patients versus none in the No SHD group (p < 0.001). Electrocardiographic parameters such as QRS duration (150 ± 14 vs. 147 ± 15 ms, p = 0.248) and QRS axis (Left axis deviation: 90 [78.3%] versus 36[81.8%] and normal axis:25[21.7%] versus 8[18.2%], p = 0.857) did not differ significantly between groups.

Assessment of coronary artery disease severity revealed that 73(45.9%) had normal coronary arteries, while 57(35.8%) had single-vessel disease, 14(8.80%) had double-vessel disease, and 12(7.54%) had triple-vessel disease. Additionally, 3(1.88%) patients had undergone coronary artery bypass grafting. In those with single vessel disease LAD was the most commonly affected (28 in 57, 49.1%), followed by LCx(16 in 57, 28.07%), RCA(10 in 57, 17.54%) and LMCA(3 in 57, 5.2%). Coronary artery disease (CAD) was present in 86 (74.8%) of the SHD patients. None of the patients No SHD group has CAD (p < 0.001).

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| **Table 1. Comparison of Clinical and Echocardiographic Parameters in LBBB Patients with and Without Structural Heart Disease** |
| | **Variable** | **SHD (n = 115)** | **No SHD (n = 44)** | **p-value** | | --- | --- | --- | --- | |  |  |  |  | | **Age (years)** | 66.5 ± 9.8 | 67.2 ± 10.1 | 0.691 | | **Valvular Disease (present, n (%))** | 29 (25.2%) | 0 (0%) | <0.001 | | **Cardiomyopathy (present, n (%))** | 50 (43.5%) | 0 (0%) | <0.001 | | **Coronary Artery Disease (present, n (%))** | 86 (74.8%) | 0 (0%) | <0.001 | | **Sex (Male, n (%))** | 74 (64.3%) | 18 (40.9%) | 0.006 | | **Chest Pain (n (%))** | 62 (53.9%) | 13 (29.5%) | 0.002 | | **Syncope (n (%))** | 9 (7.8%) | 2 (4.5%) | 0.469 | | **Old MI (n (%))** | 78 (67.8%) | 10 (22.7%) | <0.001 | | **Functional Class (NYHA)**  I  II  III  IV | 29(25.2%)  29(25.2%)  45(39.1%)  12(10.4%) | 32(72.7%)  9(20.4%)  3(6.8%)  0 | <0.001  -  -  -  - | | **Diabetes Mellitus (n (%))** | 80 (69.6%) | 31 (70.5%) | 0.784 | | **Hypertension (n (%))** | 88 (76.5%) | 37 (84.1%) | 0.949 | | **Smoking (n (%))** | 53 (46.1%) | 18 (40.9%) | 0.124 | | **Creatinine (mg/dL)** | 1.19 ± 0.35 | 0.91 ± 0.30 | 0.058 | | **Number of Diseased Vessels**  **No vessels affected**  **Single vessel disease**  **Double vessel disease**  **Triple vessel disease** | 29(25.2%)  57(49.5%)  14(12.1%)  12(10.4%) | 44(100%)  -  -  - | <0.001  -  -  -  - | | **Ejection Fraction (%)** | 44.0 ± 8.0 | 61.7 ± 10.0 | <0.001 | | **LVIDd (cm)** | 5.39 ± 0.70 | 4.60 ± 0.65 | <0.001 | | **LVIDs (cm)** | 4.05 ± 0.80 | 3.00 ± 0.75 | <0.001 | | **Mitral Regurgitation (MR)**  **Grade 3 and 4 (present, n (%))** | 26 (22.6%) | 4 (9.1%) | <0.001 | | **QRS Axis**  Left Axis Deviation  Normal Axis | 90(78.3%)  25(21.7%) | 36(81.8%)  8(18.2%) | 0.857 | | **QRS Duration (ms)** | 150 ± 14 | 147 ± 15 | 0.248 | | **Reduced EF (EF<40) (n (%))** | 44 (38.3%) | 0 (0%) | <0.001 | |

**Figure 2: Angiographic findings of patients with LBBB**  


Our study of 159 patients with left bundle branch block (LBBB) revealed that a substantial majority (72.3%) were classified as having structural heart disease (SHD) based on predefined criteria incorporating significant valvular pathology, cardiomyopathy4, and coronary artery disease (CAD). These findings are in line with previous reports suggesting that LBBB is not merely an electrical conduction abnormality but often a marker of underlying structural abnormalities1.

The demographic analysis showed no significant age difference between the two groups, but a notable disparity in gender distribution was observed, with a higher proportion of males in the SHD group (64.3%) compared to the No SHD group (40.9%). This aligns with existing literature that indicates LBBB is more prevalent in males and often correlates with underlying cardiovascular diseases2,5. Additionally, symptoms such as chest pain were significantly more common in the SHD group (53.9% vs. 29.5%, p = 0.002), while syncope rates were similar across both groups, suggesting that chest pain may be a more reliable indicator of SHD in patients with LBBB.

Functional capacity, assessed via the New York Heart Association (NYHA) classification, was significantly poorer in the SHD group compared to the No SHD group. This finding highlights the impact of structural heart disease on functional status, as patients with SHD exhibited greater limitations in physical activity and overall health status. Interestingly, while comorbidities such as diabetes and hypertension were prevalent in both groups, their rates did not differ significantly, indicating that these risk factors alone do not distinguish between SHD and No SHD patients6.  However, the trend towards higher serum creatinine levels in the SHD group indicates potential renal impairment associated with advanced heart disease, which has been previously documented as a risk factor for poor outcomes in cardiovascular patients6.

Valvular disease and cardiomyopathy were significantly more prevalent in the SHD group. According to the 2020 ACC/AHA Guideline for the Management of Patients With Valvular Heart Disease, clinically significant valvular dysfunction—typically moderate to severe—is a key determinant of adverse cardiac remodeling7. The presence of valvular diseases such as aortic stenosis can lead to increased left ventricular pressure overload and subsequent development of LBBB2,8,9. This highlights the importance of monitoring for conduction disturbances in patients undergoing procedures like transcatheter aortic valve replacement (TAVR), where LBBB may complicate postoperative recovery8.

A critical finding was the presence of coronary artery disease (CAD) in 74.8% of patients with SHD emphasizing the association between LBBB and CAD, which has been documented in previous studies1,10,11. Studies have shown that LBBB is associated with increased risks of adverse outcomes such as cardiovascular mortality and myocardial infarction1. Echocardiographic evaluations revealed significantly impaired left ventricular function among patients with SHD. The left ventricular internal dimensions were also notably larger in the SHD group, indicating structural changes associated with heart failure and cardiomyopathy. Specific echocardiographic abnormalities associated with LBBB include dynamic posterior motion of the interventricular septum during ventricular ejection, which differs from patterns observed in other conditions like volume overload states or CAD12,13. These findings suggest that echocardiography plays a crucial role in assessing cardiac function and structure in patients with LBBB.

In terms of angiographic details, among those diagnosed with CAD within this study, single vessel disease (SVD) was found to be the most common pattern of involvement14. Specifically, studies indicate that the lesions in the left anterior descending coronary artery (LAD) are frequently implicated in CAD associated with LBBB which aligns with our cohort14,15.

1. **CONCLUSION**

Our findings underscore that the left bundle branch block (LBBB) is not merely an isolated conduction abnormality but rather a clinical marker for significant underlying structural heart disease (SHD). In our cohort, a substantial proportion of LBBB patients exhibited SHD as evidenced by the markedly increased prevalence of valvular dysfunction, cardiomyopathy, and coronary artery disease. The SHD group demonstrated impaired left ventricular function with a significantly lower ejection fraction and enlarged ventricular dimensions, as well as poorer functional status based on NYHA classification. These structural and functional abnormalities are known to correlate with adverse outcomes. The implications of these findings are profound for clinical practice and patient management strategies. The significant association between LBBB and structural heart disease necessitates comprehensive cardiovascular evaluation for all patients presenting with LBBB, particularly given their increased risk for adverse cardiac events such as heart failure and sudden cardiac death.

**4.1 Limitations**

The limitations of this study should be acknowledged. Further work is needed with a larger scale of participants to support and evaluate the results of this study, since the number of cases in the present study was limited.

1. **ETHICAL APPROVAL**

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Approval for the study was obtained from the institutional ethics committee.

Disclaimer (Artificial intelligence)

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Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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Details of the AI usage are given below:

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