Original Article

# The Association of Duration of QRS Complex in Left Bundle Branch Block with Left Ventricular Systolic Function

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## Abstract

**Background:** Left bundle branch block (LBBB) indicates organic heart disease. It is responsible for a greater degree of asynchrony in the left ventricular (LV) contraction as a result of alteration in LV depolarization sequence. This study aimed to compare the duration of QRS complex in LBBB in relation to LV systolic function by two-dimensional transthoracic echocardiography. **Patients and Methods:** In this cross-sectional study, 82 patients with LBBB were divided into two groups. Group I defined as QRS <160 ms and Group II defined as QRS ≥160 ms. Then, the relationships between QRS duration and echocardiographic LV ejection fraction (EF) were derived. LV systolic dysfunction defined as EF <40%. **Results:** Eighty-two patients with (LBBB) had been included in the study, the duration of the QRS complex of 55 patients (67%) was <160 ms (Group I), and it was ≥160 ms (Group II) in 27 patients (33%). More than half (55.6%) of Group II aged ≥70 years compared with 38.2% of Group I ($P = 0.001$). Group II had high incidence of LV systolic dysfunction (70.4%) compared with 20% in Group I, while 18.2% of Group I had an EF of ≥60% compared with 3.7% in Group II ($P < 0.001$). **Conclusion:** The prolongation of QRS duration (≥160 ms) in LBBB is a marker of significant LV systolic dysfunction.

**Keywords:** Left bundle branch block, left ventricular systolic function, QRS duration

## Introduction

The left bundle branch block (LBBB) is a cardiac conduction abnormality seen on the electrocardiogram (ECG). In this condition, the activation of the left ventricle of the heart is delayed, which causes the left ventricle to contract later than the right ventricle. LBBB is defined as QRS duration ≥120 ms, QS or RS in lead V1, monophasic R wave with no Q wave in lead V6, notched R wave in lead I, aVL, V5, V6 and occasional RS pattern in V5 and V6.[1]

LBBB indicates organic heart disease. It is commonly associated with ischemic heart disease (IHD), cardiomyopathies, intrinsic disease of the conduction system, hypertensive heart disease, valvular heart disease, and acute myocardial infarction can present as new-onset LBBB.[2,3]

However, LBBB can also be seen in asymptomatic patients with a structurally normal heart in the absence of any of these risk factors.[4]

LBBB is responsible for a greater degree of asynchrony in left ventricular (LV) contraction as a result of alteration in LV depolarization sequence.[5-7] Therefore, LBBB may be a marker of both LV systolic and diastolic dysfunction due to alteration in LV depolarization and prolongation of QRS duration.

LBBB is also associated with increased mortality in patients with congestive heart failure (CHF) and carries a poor prognosis.[2,3]

The aim of our study is to compare the duration of LBBB in ECG ≥160 ms versus <160 ms in relation to LV systolic function by two-dimensional (2D) transthoracic echocardiography, etiology of LBBB, clinical features, and early in-hospital mortality of LBBB in both groups.

## Materials and Methods

This descriptive-analytic cross-sectional study was conducted in Hawler Teaching Hospital, Erbil, Iraq, From October 2018 to March 2019.

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Eighty-two patients with ECG evidence of complete LBBB visited our hospital with various complaints were studied including patients who had been admitted to coronary care unit and medical ward or patients visited the outpatient department.

Detailed and relevant history was taken, and physical examination was carried out in all.

LBBB is defined as QRS duration ≥120 ms; QS or RS in lead V1; monophasic R wave with no Q wave in lead V6; notched R wave in lead I, aVL, V5, V6; and occasional RS pattern in V5 and V6.[1,5,8-10] The patients divided into two groups according to the duration of QRS in ECG. Group I defined as QRS <160 ms and Group II defined as QRS ≥160 ms.

The enrolled patients were then evaluated for their clinical status. The medical history was recorded for the diagnosis of IHD, diabetes mellitus, hypertension, alcohol, family history of IHD, and cigarette smoking and their blood samples were analyzed for the newly diagnosis of diabetes mellitus (fasting blood sugar ≥126 mg/dl or random blood sugar ≥200 mg/dl), acute coronary syndrome (serum troponin level >0.5 ng/ml ± typical chest pain and new ischemic ECG changes) and renal function test.

Patients considered hypertensive if they have a history of hypertension or on antihypertensive medication or newly discovered hypertension according to ACC/AHA 2017 guideline for the diagnosis and treatment of hypertension.[11]

Patients aged ≥18 years of both gender with LBBB were included in this study, while those with left anterior hemiblock, respiratory failure, postpartum cardiomyopathy, rheumatic valvular heart diseases, acute renal failure, chronic kidney diseases with glomerular filtration rate <60% ml/min/1.73 $m^2$, congenital heart diseases, patients with pacemaker and patients with poor echocardiographic window were excluded from the study.

**Table 1: Patients' characteristics of the two study groups**

| | Duration of QRS | | | *P* |
|---|---|---|---|---|
| | Group I (<160 ms), *n* (%) | Group II (≥160 ms), *n* (%) | Total, *n* (%) | |
| Age | | | | |
| <50 | 6 (10.9) | 1 (3.7) | 7 (8.5) | 0.001* |
| 50-59 | 2 (3.6) | 7 (25.9) | 9 (11.0) | |
| 60-69 | 26 (47.3) | 4 (14.8) | 30 (36.6) | |
| ≥70 | 21 (38.2) | 15 (55.6) | 36 (43.9) | |
| Gender | | | | |
| Female | 28 (50.9) | 12 (44.4) | 40 (48.8) | 0.582 |
| Male | 27 (49.1) | 15 (55.6) | 42 (51.2) | |
| Hypertension | | | | |
| No | 7 (12.7) | 4 (14.8) | 11 (13.4) | >0.999* |
| Yes | 48 (87.3) | 23 (85.2) | 71 (86.6) | |
| Diabetes | | | | |
| No | 25 (45.5) | 9 (33.3) | 34 (41.5) | 0.295 |
| Yes | 30 (54.5) | 18 (66.7) | 48 (58.5) | |
| Ischemic heart | | | | |
| No | 10 (18.2) | 2 (7.4) | 12 (14.6) | 0.320* |
| Yes | 45 (81.8) | 25 (92.6) | 70 (85.4) | |
| FH of IHD | | | | |
| No | 52 (94.5) | 25 (92.6) | 77 (93.9) | >0.999* |
| Yes | 3 (5.5) | 2 (7.4) | 5 (6.1) | |
| Smoker | | | | |
| No | 37 (67.3) | 18 (66.7) | 55 (67.1) | 0.956 |
| Yes | 18 (32.7) | 9 (33.3) | 27 (32.9) | |
| Alcohol | | | | |
| No | 55 (100.0) | 24 (88.9) | 79 (96.3) | 0.033* |
| Yes | 0 (0.0) | 3 (11.1) | 3 (3.7) | |
| PCI history | | | | |
| No | 29 (52.7) | 9 (33.3) | 38 (46.3) | 0.098 |
| Yes | 26 (47.3) | 18 (66.7) | 44 (53.7) | |
| CABG | | | | |
| No | 48 (87.3) | 24 (88.9) | 72 (87.8) | >0.999* |
| Yes | 7 (12.7) | 3 (11.1) | 10 (12.2) | |
| Total | 55 (100.0) | 27 (100.0) | 82 (100.0) | |

*By Fisher's exact test. IHD: Ischemic heart disease, QRS: QRS complex in the Electrocardiography, FH: Family history, PCI: Percutaneous coronary intervention, CABG: Coronary artery bypass grafting

All patients underwent transthoracic echocardiography to search for evidence of LV systolic dysfunction. Transthoracic echocardiography examinations performed in the left lateral decubitus position using Vivid E9 (General Electric) ultrasound machine equipped with 2.3–3.5 MHz transducers. M-mode 2D echocardiography from the parasternal long axis was used to assess the LV systolic function according to the American Society of Echocardiography Guideline for the measurement of LV systolic function.[12] LV systolic dysfunction (heart failure with reduced ejection fraction [EF]) defined as EF <40%.[13]

The Scientific and Ethical Committee of Kurdistan Board for Medical Specialties has approved this study.

### Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences version 22 (SPSS, IBM company, USA). Chi-square test of association was used to compare proportions. Fisher's exact test was used when the expected count of more than 20% of the cells of the table was <5. $P \leq 0.05$ was considered statistically significant.

## Results

Eighty-two patients with LBBB had been included in the study, the duration of the QRS complex of 55 patients (67%) was <160 ms (Group I), and it was ≥ 160 ms (Group II) in 27 patients (33%). The mean age ± SD of the first group was 65.33 ± 13.58 years and that of the second group was 67.22 ± 13.67 years ($P = 0.555$).

Table 1 shows that more than half (55.6%) of those with a QRS duration of ≥160 ms aged ≥70 years compared with 38.2% of those with a QRS duration of <160 ms ($P = 0.001$). Around half (51.2%) of the samples were males, but the difference was not significant ($P = 0.582$). The majority (86.6%) of the sample had hypertension, 58.5% had diabetes, 85.4% had IHD, and only 6.1% had a history of IHD, but all the mentioned differences were not significant. The table shows that 32.9% of the samples were smokers, but no significant difference was detected between the two groups ($P = 0.956$). The table shows that 11.1% of the second group (≥160 ms**)** were alcoholics, while none of the first group were alcoholics ($P = 0.033$). Percutaneous coronary intervention PCI was done for 66.7% of the second group, and to 47.3% of the first group, but the difference was not significant ($P = 0.098$). Coronary artery bypass grafting was done for 12.2% of the sample, but no significant difference was detected between the two groups ($P > 0.999$).

Table 2 shows that 85.4% of the sample had IHD, 86.6% had hypertension, 11% had valvular heart disease, but the differences were not significant ($P = 0.320$, $P > 0.999$, and $P = 0.711$, respectively). The table shows that the proportion of dilated cardiomyopathy among the second group patients was 25.9% which was significantly higher than the proportion (3.6%) in the first group ($P = 0.005$). It is evident that 3.7% of the sample had Wolff-Parkinson-White syndrome, but the difference was not significant ($P > 0.999$). Unknown causes were present in 2.4% of the samples ($P > 0.999$).

Table 3 shows that chest pain was significantly higher ($P = 0.011$) in Group 1 (38.2%) than Group II (11.1%), and the shortness of breath was significantly ($P < 0.001$) higher in Group II (92.6%) than Group 1 (47.3%).

**Table 2: Etiological association with left bundle branch block**

| | Duration of QRS | | | *P* |
|---|---|---|---|---|
| | Group I (<160 ms), *n* (%) | Group I (<160 ms), *n* (%) | Total, *n* (%) | |
| Ischemic heart | | | | |
| No | 10 (18.2) | 2 (7.4) | 12 (14.6) | 0.320* |
| Yes | 45 (81.8) | 25 (92.6) | 70 (85.4) | |
| Hypertension | | | | |
| No | 7 (12.7) | 4 (14.8) | 11 (13.4) | >0.999* |
| Yes | 48 (87.3) | 23 (85.5) | 71 (86.6) | |
| Valvular heart disease | | | | |
| No | 48 (87.3) | 25 (92.6) | 73 (89.0) | 0.711* |
| Yes | 7 (12.7) | 2 (7.4) | 9 (11.0) | |
| Dilated cardiomyopathy | | | | |
| No | 53 (96.4) | 20 (74.1) | 73 (89.0) | 0.005* |
| Yes | 2 (3.6) | 7 (25.9) | 9 (11.0) | |
| WPW | | | | |
| No | 53 (96.4) | 26 (96.3) | 79 (96.3) | >0.999* |
| Yes | 2 (3.6) | 1 (3.7) | 3 (3.7) | |
| Unknown cause | | | | |
| No | 53 (96.4) | 27 (100.0) | 80 (97.6) | >0.999* |
| Yes | 2 (3.6) | 0 (0.0) | 2 (2.4) | |
| Total | 55 (100.0) | 27 (100.0) | 82 (100.0) | |

*By Fisher's exact test. WPW: Wolf Parkinson White Syndrome, QRS: QRS complex in the Electrocardiography

Palpitations and syncope occurred in 7.3% and 1.2% in the whole sample, respectively, but the differences were not significant between the two groups ($P = 0.390$ and $P > 0.999$, respectively).

The incidence of in hospital death in the whole sample was 4.9% as presented in Table 4 (1.8% in Group I vs. 11.1% in Group II), but the difference was not significant between the two groups ($P = 0.102$).

Table 5 shows that more than half (51.9%) of Group II had enlarged left ventricle in diastolic dysfunction compared with 12.7% of patients in Group I ($P < 0.001$). The same pattern is observed for LV diameter in systole (51.9% vs. 36.4%, respectively), but the difference was not significant ($P = 0.339$). The size of the left atrium was enlarged among the majority of patients of Group I (80%), and Group II (88.9%) but the difference was not significant ($P = 0.369$).

Table 6 shows that 70.4% of Group II had an EF of <40% compared with 20% in Group I, while 18.2% of Group I had an EF of ≥60% compared with 3.7% in Group II ($P < 0.001$).

## Discussion

Heart failure is defined as a complex clinical syndrome that can result from any structural or functional cardiac disorder that impairs the ability of the ventricle to fill or eject blood. The assessment of LV function by transthoracic echocardiography in patients with suspected heart failure leads to more effective diagnosis and treatment of this disorder.[14-16] Intraventricular conduction disturbance is common in CHF, which is characterized by a wide QRS complex.[10,17] Up to half of the advanced CHF patients have prolonged QRS duration, which has been identified as an independent prognostic factor.[9] LV dysfunction predicted by standard 12-lead electrocardiography would be clinically useful.

In this study, the role of sex is not correlated to QRS duration ($P > 0.05$), but more than half of Group II patients aged ≥70 years compared with 38.2% of Group I ($P = 0.001$). Our findings regarding the role of sex in relation to the duration of QRS are consistent with Anastasiou-Nana *et al*.[18] and Pastore *et al*.,[3] but do not agree regarding the role of age.

In our study, we divided QRS duration into <160 ms (Group I) and ≥160 ms (Group II), but Sandhu and Bahler[19] divided this duration on the basis of 120 ms, and Bode-Schnurbus *et al*.,[20] decided the duration on the basis of 150 ms. The probable cause of this difference is due to different sample size and measurement methods. Moreover, several studies of QRS duration have shown that a prolonged QRS (>170 ms) is associated with LV dysfunction.[8,9,21,22] Our data indicate that the presence of wide QRS ≥160 ms is associated with LV systolic dysfunction. As in our study, Das *et al*. concluded that the QRS duration of ≥170 ms in the presence of LBBB has a significant inverse relationship with EF.[5]

**Table 3: Symptoms in each of the study groups**

| | Duration of QRS | | | *P* |
|---|---|---|---|---|
| | Group I (<160 ms), *n* (%) | Group II (≥160 ms), *n* (%) | Total, *n* (%) | |
| Chest pain | | | | |
| No | 34 (61.8) | 24 (88.9) | 58 (70.7) | 0.011 |
| Yes | 21 (38.2) | 3 (11.1) | 24 (29.3) | |
| SOB | | | | |
| No | 29 (52.7) | 2 (7.4) | 31 (37.8) | <0.001 |
| Yes | 26 (47.3) | 25 (92.6) | 51 (62.2) | |
| Palpitation | | | | |
| No | 52 (94.5) | 24 (88.9) | 76 (92.7) | 0.390* |
| Yes | 3 (5.5) | 3 (11.1) | 6 (7.3) | |
| Syncope | | | | |
| No | 54 (98.2) | 27 (100.0) | 81 (98.8) | >0.999* |
| Yes | 1 (1.8) | 0 (0.0) | 1 (1.2) | |
| Total | 55 (100.0) | 27 (100.0) | 82 (100.0) | |

*By Fisher's exact test. SOB: Shortness of breath, QRS: QRS complex in the Electrocardiography

**Table 4: Incidence of death in the two study group**

| Death in hospital | Duration of QRS | | | *P* |
|---|---|---|---|---|
| | Group I (<160 ms), *n* (%) | Group II (≥160 ms), *n* (%) | Total, *n* (%) | |
| No | 54 (98.2) | 24 (88.9) | 78 (95.1) | 0.102* |
| Yes | 1 (1.8) | 3 (11.1) | 4 (4.9) | |
| Total | 55 (100.0) | 27 (100.0) | 82 (100.0) | |

*By Fisher's exact test. QRS: QRS complex in the Electrocardiography

**Table 5: Structural heart abnormalities by echocardiography in relation to QRS duration**

| | Duration of QRS | | | *P* |
|---|---|---|---|---|
| | Group 1 (<160 ms), *n* (%) | Group II (≥160 ms), *n* (%) | Total, *n* (%) | |
| LVDD | | | | |
| <38 | 1 (1.8) | 0 (0.0) | 1 (1.2) | <0.001* |
| 38-56 | 47 (85.5) | 13 (48.1) | 60 (73.2) | |
| >56 | 7 (12.7) | 14 (51.9) | 21 (25.6) | |
| LVSD | | | | |
| <22 | 3 (5.5) | 2 (7.4) | 5 (6.1) | 0.339* |
| 22-38 | 32 (58.2) | 11 (40.7) | 43 (52.4) | |
| >38 | 20 (36.4) | 14 (51.9) | 34 (41.5) | |
| LA size | | | | |
| 19-33 | 11 (20.0) | 3 (11.1) | 14 (17.1) | 0.369* |
| >33 | 44 (80.0) | 24 (88.9) | 68 (82.9) | |
| Total | 55 (100.0) | 27 (100.0) | 82 (100.0) | |

*By Fisher's exact test. LVDD: Left ventricular diastolic dysfunction, LVSD: Left ventricular systolic dimension, LA: Left atrium, QRS: QRS complex in the Electrocardiography

**Table 6: Left ventricular ejection fraction in relation to QRS duration**

| EF | Duration of QRS | | | *P* |
|---|---|---|---|---|
| | Group 1 (<160 ms), *n* (%) | Group II (≥160 ms), *n* (%) | Total, *n* (%) | |
| <40 | 11 (20.0) | 19 (70.4) | 30 (36.6) | <0.001 |
| 40-49 | 17 (30.9) | 5 (18.5) | 22 (26.8) | |
| 50-59 | 17 (30.9) | 2 (7.4) | 19 (23.2) | |
| ≥60 | 10 (18.2) | 1 (3.7) | 11 (13.4) | |
| Total | 55 (100.0) | 27 (100.0) | 82 (100.0) | |

EF: Ejection fraction, QRS: QRS complex in the Electrocardiography

## Conclusion

The QRS duration in LBBB has a significant inverse relationship with EF. Moreover, the prolongation of QRS duration (≥160 ms) in LBBB is a marker of significant LV systolic dysfunction.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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