Original Article

Association of QRS Duration with Echocardiographic Left Ventricular Dimensions

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Abstract:

Background: QRS duration (QRSd) is used to diagnose left bundle branch block (LBBB) and is important for determining cardiac resynchronization therapy eligibility. Others have reported associations of left bundle branch block (LBBB) and interventricular conduction delay with left ventricular (LV) systolic and diastolic dysfunction in patients without clinical HF. Individualized QRSd thresholds may improve diagnosis and intervention strategies. The goal of this study was to assess the relations of QRS duration to echocardiographic left ventricular (LV) dimensions in individuals.

Methods: This was a hospital-based cross-sectional analytical study. A total of 134 purposively selected respondents were included in the study from the patients attending the outpatient or inpatient department of cardiology, Dhaka Medical College Hospital, advised for an echocardiogram. They were divided into two groups depending on their QRS complex duration (Group I≤100 ms and Group II >100 ms). After taking informed written consent, a case record form was filled and Echo measurements were taken following standard procedure with confidentiality.

Results: Among the respondents, the mean age was found 52.68 ± 14.24 years. The majority were male (68%), and around 1/3rd of the respondents were overweight or obese. Males were found to have less QRS duration than females (p<0.001) but there was no difference in age (p=0.814) between the groups. All the risk factors considering obesity, diabetes mellitus, hypertension, family history, smoking status, and dyslipidemia were found in similar proportions in both groups (p>0.05). The study found that the interventricular septum thickness and inferolateral wall thickness were higher among those having a QRS duration of more than 100 ms (Group II), but this difference was not significant (p > 0.05). On the other hand, left ventricular diastolic dimension, systolic dimension, and left ventricular mass were found to be increased significantly (p<0.05) with a reduction in ejection fraction in Group II (p<0.05).

Conclusion: Left ventricular diastolic and systolic dimensions along with left ventricular mass significantly increase according to QRS duration among the patients. Meanwhile, a reduction in ejection fraction was also evident.

Keywords: *QRS duration, LV dimensions*

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Introduction:

QRS duration serves as a key prognostic and diagnostic determinant of several cardiac conditions.[1] Prolonged QRS duration (QRSd) is a marker of long-term mortality in different patient categories.[2,3] However large interindividual variability of the QRS duration exists, not only in different patient categories but also in healthy subjects.[4] Normal values of the QRS duration can overlap with abnormal values suggesting heart disease. Distinguishing between abnormal QRS duration and normal variants can be difficult.[5]

A QRSd ≥120 ms has traditionally been classified with complete bundle branch blocks and unspecified intraventricular conduction delay, and a QRSd ≤100 ms has been considered normal. A QRSd between 100 and 120 ms is considered prolonged, specifying either incomplete bundle branch block or intraventricular conduction delay. The degree of QRS widening may be a manifestation of left ventricular (LV) structure (such as increased LV mass or LV dimension). Still, it can also suggest functional abnormalities, such as LV systolic dysfunction (LVSD).[6]

Standard 12 lead electrocardiography remains the most widely used initial screening test for the noninvasive detection of left ventricular hypertrophy, However, electrocardiographic (ECG) criteria based only on QRS voltage have exhibited poor sensitivity for left ventricular hypertrophy at the high levels of specificity necessary for adequate clinical utility.[7,8]

Again, a prolonged electrocardiographic QRS duration (≥120ms) may be a marker of inter or intraventricular mechanical dyssynchrony, and has been associated with adverse prognosis in systolic heart failure.[9] Cardiac resynchronization therapy has favorably influenced clinical outcomes in systolic HF patients with QRS duration ≥150 ms.[10] Others have reported altered electrical activation in patients with isolated LBBB causing ventricular abnormalities, manifested by abnormal diastolic filling times, abnormal heart sounds, abnormal interventricular septal motion, abnormal left ventricular regional ejection fraction, and interventricular conduction delay.[3,11] This is also a fact in left ventricular (LV) systolic and diastolic dysfunction in patients without clinical HF.

LV chamber size and wall thickness represent the determinants of decision-making in several clinical Guidelines.[12,13] Measurement of these critical parameters by transthoracic echocardiography (TTE) in the parasternal long-axis (LAX) view is supported by accepted conventions whereas cardiovascular magnetic resonance (CMR) lacks a standardized approach to clinical routine.[14,15] The presence of left ventricular hypertrophy detected by echocardiography has been associated with an increased risk of future cardiac morbidity and mortality both in hypertensive patients[16,17] and in a sample of the general population.[1819] So echo diagnosis of LVH is a simple cost-effective screening method and a clinical priority.[20] These reports linking increased QRS duration to LV dysfunction are paralleled by reports emphasizing associations of prolonged QRS duration with LV structural changes.[21] Experimental investigations suggest that asynchronous LV contraction (indicated by prolonged electrocardiographic QRS duration) may promote LV remodeling, manifested by increases in wall thickness of late-activated LV segments.[19,20]

Several studies have shown a correlation between LV size and QRSd.[22,23,24] LV mass, diameter, volumes, and length have all been shown to correlate positively with QRSd both in patients with and without the presence of bundle branch block.[22,23] Of these measurements, indices of LV dilatation (LV volumes and diameters) have been more.

Methods:

This cross-sectional analytical study was conducted at the Department of Cardiology, Dhaka Medical College Hospital (DMCH), Dhaka between May 2019 to April 2020. The study protocol was approved by the Ethical Review Committee (ERC) of Dhaka Medical College and Hospital. Patients advised for ECG and echocardiography from OPD/IPD of the Cardiology Department, Dhaka Medical College Hospital, within the study period, who fulfilled the inclusion and exclusion criteria were included in this study by convenient purposive sampling. Patients suffering from heart failure, having a history of previous MI, PTCA, CABG, cardiomyopathy, valvular and congenital heart disease, pacemaker implantation taking digoxin or quinidine, having electrolyte imbalance, arrhythmias and unwilling to participate were excluded from the study. All the participants included in this study were informed about the nature, risks, and benefits of the study. Informed written consent was taken from all patients. Among the patients advised for ECG and echocardiography from OPD/IPD, Cardiology, Dhaka Medical College Hospital was initially sorted to find out eligible respondents. Those who were eligible underwent electrocardiography and echocardiography. Advanced 12 lead ECG machine (Advanced electrocardiograph, model: ECG-12C manufactured by advanced Instrumentations, INC, USA) was used for electrocardiography (Electrocardiographs automatically measure the QRS duration which is globally measured from the earliest onset to the latest

offset of the QRS complex and averaged among all 12 leads) and evaluated by the principal investigator. A total of 134 study subjects were included in the study, they were divided into two groups according to the QRS duration on 12 Leads surface ECG. Subjects with QRS duration ≤100 ms were taken in Group I and subjects with QRS duration >100 ms were taken in Group II. Transthoracic echocardiography was performed among all the study subjects in a Philips Affiniti 70c echocardiography machine and the LV dimensions were measured. Patients were positioned in left lateral decubitus and a raised left arm. Images were displayed on the echocardiographic system and measurements were obtained from recordings in the parasternal LAX acoustic window directly from the 2D images. Dimensions were measured in the LV minor axis plane at the mitral chordae level at the tips of the papillary muscles. LVIDd and LVIDs, respectively, and wall thickness (anteroseptal – IVSd and inferolateral – LVPWd) were measured at end-diastole(d) and end-systole(s) respectively, and were averaged over three consecutive heart cycles. All the results were validated by two competent cardiologists. The ejection fraction was measured in the modified Simpsons biplane method. A4C view was used. Detailed clinical history and physical examination were done and required data were recorded in a preformed data collection sheet. Interviews of the participants were conducted to ascertain socio-demography-related information (age, sex), health status information about risk factors for coronary heart disease (diabetes, hypertension, dyslipidemia, smoking, and family history of premature coronary artery disease), and physical measurement (blood pressure, height, and weight). All the information was recorded properly in the preformed data collection sheet. After compiling data from all patients, statistical analysis was done. Statistical analysis was performed using SPSS 21.0 for Windows. p-value < 0.05 was considered statistically significant.

Results:

This cross-sectional analytical study was carried out in the Department of Cardiology, Dhaka Medical College Hospital, Dhaka from May 2019 to April 2020. The primary objective was to find out the difference in echocardiographically determined left ventricular dimensions between the study subjects having QRS duration >100 ms and ≤100 ms. A total number of 134 patients who fulfilled inclusion and exclusion criteria, were included in the study. The patients were classified into two groups based on QRS duration. The patients with QRS duration d”100 ms were assigned to Group I (n = 67) and those with QRS duration >100 ms were assigned to Group II (n = 67).

Fig:1 shows the distribution of the respondents according to their age. The minimum age was found 18 years and the maximum was 80 years. The mean age was found 52.68 ±14.24 years.

The mean age of the total population was 52.7±14.2 years. The major proportion 56(41.8%) were in the 40–59 years age group. Age distribution was similarly distributed between both groups (p=0.814).

Among the study subjects, the majority of the respondents were males (91, 68%). The rest of them were females (43,32%).

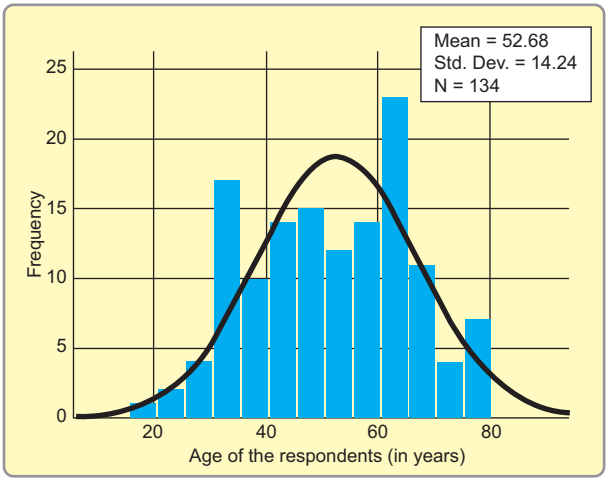

Figure 1: *Distribution of the respondents according to their age (n=134)*

Table-I

Distribution of the study subjects by age (n = 134)

Age group(years)	Total (n=134)		Group I (n=67)		Group II (n=67)		p-value
	No.	%	No.	%	No	%	
18-39	27	20.1	13	19.4	14	20.9	0.938^{ns}
40-59	56	41.8	29	43.3	27	40.3	
≥60	51	38.1	25	37.3	26	38.8	
Mean±SD(years)	52.7±14.2		52.9±13.6		52.4±14.9		0.814^{ns}

The Chi-square Test ($\chi^2$2) was done to observe an association between variables and
An Independent sample t-test was done to compare Mean±SD. ns = not significant
Group I: patients with QRSd ≤100 ms; Group II: patients with QRS>100 ms

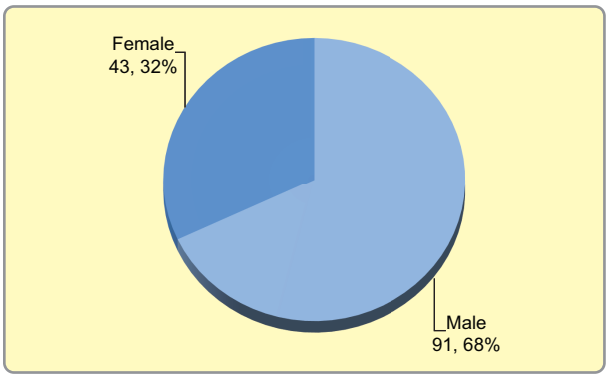

Figure 2: *Distribution of the total respondents according to their sex (n=134)*

Table II shows the distribution of cardiovascular risk factors among both groups which are similarly distributed.

Table III shows echocardiographic variables in between groups. LV mass, LV systolic dimension, and LV diastolic dimension are significantly higher in Group II (p-value 0.002, 0.001, and <0.001 respectively). Whereas, inferolateral wall thickness and interventricular septal thickness in diastole are similarly distributed between groups. Ejection fraction is significantly reduced in Group II (p=.001)

Table-II

Distribution of the study subjects according to cardiovascularrisk factors (n = 134)

Risk factors	Group I (n=67) No (%)	Group II (n=67) No (%)	p-value	
BMIcategory	Underweight	5 (7.5%)	4 (5.9%)	0.700^{ns}
	Normal weight	42(62.7%)	38(56.7%)	
	Overweight	17 (25.4%)	19 (28.4%)	
	Obese	3 (4.5%)	6 (8.9%)	
Diabetes Mellitus	19 (28.4%)	19 (28.4%)	1.000^{ns}	
Hypertension		22 (32.8%)	23 (34.3%)	1.000^{ns}
Family History of Premature CAD	8 (11.9%)	6 (8.9%)		
			0.778^{ns}	
Smoking	Ex-smoker	10 (14.9%)	5 (7.4%)	
	Present smoker	16 (23.9)	13 (19.4%)	
				0.256^{ns}
	Non-smoker	41 (61.2%)	49 (73.1%)	
Dyslipidemia		21 (31.3%)	24 (35.8%)	0.714^{ns}

Chi-squared Test (χ^2) was done to observe the association. ns = not significant
Group I: patients with QRS ≤100 ms; Group II: patients with QRS>100 ms

Table-III

Distribution of the study subjects by Echocardiographic variables(n=134)

Echocardiographic Variables	Mean+SD		
	Group I	Group II	P value
LV mass (gram)	96.9±26.6	118.0±46.7	0.002s
Inferolateral wall thickness (mm)	8.3±1.6	8.4±1.8	0.7605
LV systolic dimension (mm)	26.5±3.5	29.1±4.3	0.001s
LV diastolic dimension (mm)	40.2±4.7	43.9±5.4	0.001s
Interventricular septal thickness in diastole (mm)	7.9±1.6	8.2±2.0	0.326ns
Ejection Fraction (%)	62.6±5.6	59.0±4.2	0.001s

Unpaired Student t-test was performed to compare between groups
ns=not significant; s=significant
Group I = QRS duration ≤100 ms; Group II = QRS duration >100ms

Discussions:

In this study, the major proportion 56(41.8%) belonged to the age group 40-59 years. The mean age of the total population was 52.7±14.2 years. Age in both groups were similarly distributed (p=0.814). Chan et al in 2014 found a mean age of 56 years which is similar to our study.[22]

The number of males in Group I and Group II was 57(85.1%) and 34(50.7%) respectively. The number of females was higher in Group II than in Group I. Predominance of male gender was statistically significant in Group I (p<0.001) and gender distribution was nearly equal in Group II which is different from other studies conducted before. In patients with QRSd >100ms number of male patients was found significantly higher in studies conducted by Rickard et al. in 2017 (p≤0.03)[22] and Ilkhanoff et al. in 2012 (p<0.01)[6]. Dhingra et al. 2005 showed that the association between all the parameters regarding LVEDD, LV mass, and wall thickness vs QRSd was consistent in both genders which is similar to our study.[23] The reason for this difference from other studies might be due to the relatively smaller sample size and single center-based sample collection.

Regarding risk factors of IHD, they were similarly distributed in both groups and there was no significant association with QRSd and LV dimensions. Among the echocardiographic variables, LV mass, LV systolic dimension, and LV diastolic dimension were significantly higher in Group II (p-value 0.002, 0.001, and <0.001 respectively). Whereas, the thickness of the inferolateral wall and interventricular septum in diastole were also higher in group II which is not statistically significant (0.76, 0.32). That also shows the similarity with the study done by Dhingra et al. in 2005 (p<0.05).[23] Braun et al. (2005) also found a similar relationship.[26] Chan et al. in 2014 found a positive correlation between inferolateral wall thickness and QRS duration (p=0.002).[22] This may happen due to our small number of study subjects.

A weak but nonsignificant correlation between LVEDD and QRS duration in patients with non-LBBB QRS morphology among the study population was evident in another study done by Rickard et al. in 2017.[25] Hakacova et al. in 2010 found that the influence of the left ventricular mass on the QRS duration does not seem to have a dominant role (p=0.05).[5] But both Dhingra et al. in 2005 and Chan et al. in 2014 found this relationship significant (p<0.001).[22,23]

Regarding the systolic function, this study found significantly (p= 0.001) reduced ejection Fraction, in Group II (QRS duration >100 ms) than those in Group I (QRS Duration ≤100 ms). This evidence also coincides with the previous findings by Dhingra et al. in 2005 and Wang et al. in 2008.[23,27] Dhingra et al. in 2005 showed that fractional shortening was significantly lower in patients with QRSd>100ms and inversely proportional.[23]

Considering other studies and results that we found, 12 lead ECG tracing can be used as a predictor for assuming anatomical changes but it did not correlate strongly. It is difficult to comment about any normality or abnormality based on one categorical data only whether it is electrophysiological or anatomical. Though in our study, parameters like LVEDD, LVESD, LV mass, and ejection fraction were strongly associated with QRSd based on parameters like wall thickness (IVS and inferolateral wall) we can predict QRSd weakly. So for deciding the case of future management of a patient, we advise considering both electrophysiological and anatomical modalities to be reviewed.

Conclusion:

In our hospital-based cross-sectional analytic study, we observed a positive association between wide QRS duration and echocardiographic findings of LV mass, LV diastolic dimension, and LV systolic dimension. The association between wall thickness (IVS and inferolateral wall) and QRSd was nonsignificant. On the other hand, the inverse relationship between QRS duration and systolic function was also observed considering a significant decrease in ejection fraction.

Limitations of the study:

Although the result of this study supports the hypothesis, there are some facts to be considered which might have affected the result of the current study. It was a single-center study. The study population was small. Purposive sampling was done instead of random sampling. Therefore, the results of the study may not reflect the exact picture of the country. Follow-up of the patients for a longer duration was beyond the scope.

Recommendations:

To confirm these findings additional investigations are warranted with a heterogeneous group of people. Further clinical study with a larger sample size involving multiple centers is recommended.

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