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The relationship between QT interval and QT dispersion with left ventricular ejection fraction in patients with LBBB or RBBB

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ABSTRACT

We aimed to determine the relationship between QT interval and QT dispersion with left ventricular systolic function (LVSF), in patients with left or right bundle branch block (LBBB or RBBB). In this cross-sectional study, 80 convenience samples of patients with LBBB and RBBB were recruited from March to September 2015 in Kerman. The relationship between QT interval and QT dispersion (based on electrocardiogram) with LVSF (based on echocardiography) was measured using Chi square and student T test. The findings were compared between LBBB and RBBB cases. Left ventricular systolic dysfunction (LVSDF) in LBBB cases was more prevalent than RBBB. (80% vs. 45%). The QT dispersion was seen in 100% and 95% of cases with LBBB and RBBB respectively. The increased QT interval was more frequent in LBBB (92.5%) than RBBB (80%). In LBBB, with prolonged QT interval, LVSDF was more prevalent than normal QT interval sub group. (81% vs. 66%) but in RBBB only the prevalence of severe LVSDF had increased in the prolonged QT interval subgroup. (21% vs. 12%). In patients with BBB, especially LBBB, there is a direct significant relationship between prolonged QT interval and left ventricular ejection fraction (LVEF). So after diagnosis of BBB in ECG, it is better to calculate QT interval until if it is prolonged, evaluation of LVEF with echocardiography was done. On the other hand, QT interval is a diagnostic key for estimation of LVSF in patients with BBB.

Keywords: long QT syndrome, Left bundle- branch block, Right bundle- branch block, ventricular function, left.

INTRODUCTION

ECG has always provided very useful information that can be used to diagnosis, treatment and prevention of cardiovascular events. One of these most important findings is the QT interval. The period from the beginning of the QRS wave to the end of the T wave is QT interval. In fact, it is the overall time of activity and ventricular recovery and shows the action potential of the heart. The QT interval is affected by some pathological conditions such as myocardial ischemia, diabetic neuropathy and genetic syndromes[1],[2],[3],[4].This period also is affected by certain physiological conditions such as heart rate and non-sinusoidal rhythm[5],[6],[7],[8],[9]. So the equations to correct this gap and reduce the impact of heart rate variability are designed[10],[11],[12],[13]. This distance has been of key importance. So far, several studies have investigated the relationship between QT interval with risk of

cardiovascular mortality and morbidity [14],[15],[7],[16],[12],[17],[18],[19],[20],[21].that such studies can be noted Padmanabhan, Vanderbijl and MESA study. However, conflicting results have been obtained in some studies such as the Framingham study[22].There is action potential difference between the layers of the heart that QT dispersion shows this difference.In fact, this period achieved by subtracting the minimal distance from the greatest distance of QT interval and represents the electrical homogeneity of heart cells[23]. The key importance of QT dispersion and the dangers of prolonged QT dispersion including ventricular arrhythmia have been identified in several studies, including Harjai and colleagues [10],[23],[24],[25]. Other key finding that obtains from an ECG is recognition the LBBB and RBBB that has significant importance in patients with ischemic heart disease as well as conduction disturbances. In several studies, including Pai and colleagues the association between QT interval and BBB is specified[26],[27],[28],[29]. Echocardiography is a very important instrument in medicine. It is possible to measure LVSF as ejection fraction[LVEF].That the relationship between the QT interval and LVEF has been shown in many studies[30],[31],[32].In most of the studies mentioned, the sample consisted of patients with heart failure and in some of them, BBB were excluded from the study. But in none of them, all these variables [QT interval, QT dispersion, BBB and LVSF] are not considered simultaneously. Therefore, we decided to study the relationship between QT dispersion and QT interval with LVSF in BBB.

MATERIALS AND METHODS

Study sample

This cross-sectional study was done on 40 patients with LBBB and 40 patients with RBBB who admitted between March and September 2015to cardiology service of Shafa hospital in Kerman, Iran.

The diagnostic criteria for LBBB were:
1- QRS duration ≥12O(msec).2-Broad, notched or slurred R waves in leads I,avl,v5,v6.3- small or absent initial r waves in right precordial leads (v1,v2)followed by deep s waves.4- Absent septal q waves in leads I,V5,V6.5- Prolonged time to peak R waves (>60 msec) in v5 ,v6.

The presence of RBBB was based on the following criteria:
1-QRS duration $\geq 120(msec)$2-rsr′,rsR′orrSR′ patterns in v1,v2. 3- S waves in lead I and V6$\geq$ 40 $(msec)wide$.4-Normal time to peak R waves in v5, v6 but > 50(msec) in v1.

INSTRUMENTS:

Demographic data, risk factors, history of cardiovascular disease and medications were collected through face-to face interviewwith each patientor their caregivers using structured questionnaire. The exclusion criteria were: 1-consumption of drugs that prolong the distance of QT (anti-arrhythmic class III, IA, etc.) at the time of study.2-Acute electrolyte disorders (hypokalemia, hypomagnesaemia, hypocalcaemia) .3 - diabetes type one. 4-Hypothyroidism. 5- Lesions of central nervous system (brain hemorrhage).6- patients with PPM (permanent pacemaker) or CRT (cardiac Resynchronization Therapy).The dependent variables including QT interval, QT dispersion and LVSF were measured as follow. QT interval was defined as highest distance from the start of QRS to the end of the T wave. This was corrected using the following equations: 1-Bazett formula (QT max /√R-R). 2-AHA formula [QT max + 1.75(HR-60)]. The average values higher than 440 (m sec) considered as prolonged QT interval. The QT dispersion was measured as the difference between the longest and shortest QT interval in the ECG. The value>56 (m sec) was considered as dispersion. To calculate LVSF, LVEF was measured according to Simpson method using trans-thoracic echocardiography. To obtain the severity of LVSDF, LVSF was categorized as.[normal(EF≥50%),mild LVSDF(EF=40-50%),moderate LVSDF(EF=30-40%),severe LVSDF(EF<30%)].

Statistical analysis

The results for quantitative and qualitative variables were expressed as mean±standard deviation and frequency/ percentage respectively. Paired T-test, student T-test, Chi-square test and univariate linear regression were used to compare the variable between two groups. All data were analyzed using SPSS22 software. P-value lower than 0.05 considered as level of significance.

Ethical considerations: Informed consent was obtained from all participants. All procedures was done free of charge for all individuals. The study protocol was reviewed and approved by ethic committee of Kerman University of medical sciences (ir.kmu.rec.1394.719).

RESULTS

The mean±sd of age in patients with LBBB and RBBB was 62±14.72 years and 60±12.72 years respectively. 55% of patients in LBBB group and 25% in RBBB group were women. The difference was significant. (p_value<0.01). The average age of the LBBB in subgroup with long QT interval, was 61±13.9 years, with no significant difference with his teammate on the RBBB (58±11.8 years).The mean of left ventricular ejection fraction (LVEF) in LBBB was significantly lower than RBBB (30%±14.693 vs44%±12.820, P-value<0.0001) (Table 1). Totally 80% of LBBB patients had LVSDF while only 45% of RBBB patients had LVSDF. The difference was significant (P<0.001) (Table1). The frequency of prolonged QT interval in LBBB is more significant than RBBB. (92.5% VS80% P-value =0.02). (Table 1). In both BBB groups prevalence of prolonged QT interval was more significant than normal QT interval. (92.5% VS 7.5% in LBBB) and (80 % VS 20% in RBBB). (Table1) .The mean of QT dispersion in the LBBB was109±42.475 and in RBBB was 104±40.307 (m sec) the difference was not significant. The entire LBBB group and 95% in the RBBB group had QT dispersion. The difference between 2 BBB groups was not significant. The average of BazettQT distance in LBBB was significantly higher than RBBB (534.78±81.849Vs496.83±61.729 msec P-value<0.05).While thedifference of AHA QT interval in two groups was not statistically significant. Maximum QT interval in the LBBB was 535.28±81.387 and in the RBBB, was 496.95±61.625 (m sec). This difference was statistically significant. (P-value<0.05)(table1)

(TABLE1)Comparison of left ventricular systolic dysfunction severity, QT interval and QT dispersion inpatients with left and right bundle branch block

Variable		LBBB	RBBB	P-Value
LVEF (mean±sd)		44%±12.820	30%±14.693	<0.0001**
Severity of LVSDF Frequency (%)	Normal	8(20%)	22(55%)	<0.001*
	Mild	4(10%)	10(25%)	<0.001
	Moderate	10(25%)	3(7.5%)	<0.001
	Severe	18(45%)	5(12.5%)	<0.001
Maximal QT interval	prolonged	37(92.5%)	32(80%)	=0.02*
	Normal	3(7.5%)	8(20%)	=0.02
QT dispersion	Yes	100%	95%	*>0.05
	No	0%	5%	>0.05
QT interval mean±sd	Bazett	534.78±81.849	496.83±61.729	<0.05**
	AHA	493.38±61.488	479.7±50.306	>0.05**
Maximal QT interval mean ±sd		535.28±81.387	496.95±61.625	<0.05**

**chisquare test. **Student T-test. RBBB=right bundle branch block. LBBB=left bundle branch block.LVEF=left ventricular ejection fraction.*

Comparison of QT dispersion, QT interval with both formulas and maximal QT interval between two genders did not show significant difference. (table2).

Table2. Comparison of QT dispersion and QT interval between two genders

Variable		Gender		P-value
		Female	Male	
QT dispersion mean±sd	LBBB	105.45±43.723	113.33±41.727	>0.05**
	RBBB	100±50.772	105.33±33.114	>0.05**
QT interval Bazett	LBBB	544±67.141	523±97.753	>0.05**
	RBBB	496.70±63	496.87±62	>0.05**
QT interval AHA	LBBB	496.64±51.975	489.39±72.842	>0.05**
	RBBB	467.20±46	483.03±51	>0.05**
Maximal QT interval	LBBB	544.05±67.124	524.56±96.999	>0.05**
	RBBB	496.70±63	497.03±62	>0.05**

**Chisquare test. **Student T-test. RBBB=right bundle branch block. LBBB=left bundle branch block.*

Compare the LVSDF in patients with LBBB according to sex showed that the LVSDF is more prevalent in men than in women. (89% VS 73%. P-value<0.05). Also in RBBB group the prevalence of LVSDF in men was more than women. (53% vs. 20% P-value=0.02). And severity of LVSDF in men was higher than women. (Table 3)Comparison of left ventricular ejection fraction in LBBB between men and women showed that the LVEF in men is less than women. (24.72%±13.226 vs.35%±14.475). This difference was significant. (P-value = 0.02). But this difference was not significant in RBBB group.(43.33%±12.54 vs. 47.5%±13.79) (Table 3)

Table 3.Comparisonof LVSF in LBBB and RBBB in both genders

Variable			Gender		P-value
			Female	Male	
LVSDF frequency %	LBBB	Normal	6(27.3%)	2(11.1%)	<0.05*
		Mild	3(13.6%)	1(5.6%)	<0.05*
		Moderate	6(27.3%)	4(22.2%)	>0.05*
		Severe	7(31.8%)	11(61%)	=0.02*
	RBBB	Normal	8(80%)	14(46.7%)	=0.02*
		Mild	1(10%)	9(30%)	<0.05*
		Moderate	0(0%)	3(10%)	<0.05*
		Severe	1(10%)	4(13.3%)	>0.05*
LVEF mean ±sd	LBBB		%35±14.47	24.72%±13.22	=0.02**
	RBBB		47.5%±13.79	43.33%±12.54	>0.05**

**Chisquare test. **Student T-test. RBBB=right bundle branch block. LBBB=left bundle branch block. LVEF =left ventricular systolic dysfunction.*

In LBBB, LVSDF was more prevalent in prolonged QT interval subgroup than normal QT interval. (81% vs. 66%). This difference was significant.(P-value<0.01).But in the RBBB group this difference was not significant. (45% vs 50%). The prevalence of LVSDF in prolonged QT interval cases of LBBB group was more than RBBB. (Table 4). In patients with RBBB prevalence of severe LVSDF in prolonged QT interval subgroup was more than normal QT

Interval. (21.87% vs 12.5% p-value <0.05). In LBBBthe frequency of normal LVSF in subgroup with prolonged QT interval was less than subgroup with normal QT interval. (18.9% vs. 33%p-value <0.05)(Significant difference),while the prevalence of mild to moderate LVSDF was greater in the subgroup with long distance. (8% vs 0% p-value <0.05) (Significant difference). But in the sub group with severe dysfunction the difference was not significant. (Table4)

Table4. Comparison of LVSF in LBBB and RBBB according to QT interval

Variable			Maximal QT interval		P-value
			Prolonged	Normal	
LVSDF frequency %	LBBB	Normal	7 (18.9%)	1 (33.33%)	<0.05*
		Mild	3 (8%)	0%	<0.05*
		Moderate	5 (13.5%)	0%	<0.05*
		Severe	22 (59.4%)	2 (66.66%)	<0.05*
		Total	30(81%)	2(66.66%)	<0.01*
	RBBB	Normal	17 (53%)	4 (50%)	>0.05*
		Mild	4 (12.5%)	1 (12.5%)	>0.05*
		Moderate	4 (12.5%)	2(25%)	<0.05*
		Severe	7 (21.87%)	1(12.5%)	<0.05*
		Total	15(46.87%)	4(50%)	>0.05*

**Chisquare test. **Student T-testLBBB=left bundle branch block.RBBB=right bundle branch block. LVSDF=left ventricular systolic dysfunction.*

DISCUSSION

The entire LBBB group and the majority of the RBBB group have QT dispersion. Also in majority of BBB cases, QT interval is prolonged. So we conclude that BBB (LBBB or RBBB) correlates with abnormal electrical homogeneity. The mean of LVEF in LBBB is less than the RBBB group. The majority of cases with LBBB had LVSDF but less than half of RBBB cases had LVSDF. The prevalence of moderate to severe LVSDF in patients with LBBB is more than the RBBB. So we can say that the prevalence of reduced LVEF, LVSDF and prolonged QT interval, in LBBB is more than RBBB. On the other hand LBBB impact on the LVSDF and cardiac electrical conduction is greater than RBBB. A reason is that LBB is composed of two fascicles (left anterior and left posterior) and greater part of the heart is affected by LBBB than RBBB. So we must face to BBB, especially LBBB, more intensive than usual. In the LBBB, the prevalence of LVSDF in prolonged QT interval was more than normal group. This finding shows the correlation between QT interval and LVSF in LBBB. But in the RBBB, QT interval prolongation, correlates only with severe LVSDF. So we must calculate QT interval in both LBBB and RBBB cases, until if it is prolonged, LVEF evaluate with echocardiography. In this way we can diagnose LVSDF in early stages, in LBBB or RBBB. The prevalence of severe LVSDF in men with LBBB was more than women. Also the mean of LVEF in patients with LBBB, was lower in men than women. These results show that LBBB impact on the LVSF in men is more than women.

Several studies have shown an association between increased QT interval and mortality, some of them are: Padmanabhan et al. (2003) showed that an increase in QT interval strongly was associated with mortality rate particularly in patients with LVSDF. Also, the QT interval greater than 350 (m sec) in at least six leads was associated with an increased risk of mortality. This relationship is particularly high in patients with old age as well as patients with severe LVSDF (17). Also In our study association between the increase in the QT interval with LVSDF, especially in the LBBB group was identified. So we can conclude that the findings obtained in our study were associated with increased mortality. In Van der Bijl et al study in2012; the relationship between QT prolongation and an increased risk of six months mortality in patients undergoing coronary angiography were studied. In this study, patients with BBB were excluded.So the QT prolongation has a direct statistical correlation with the occurrence of mortality. Also, the relationship between QT prolongation and decreased LVEF was statistically significant (18).In our study as the vanderbijl study the association between the QT interval with reduced ejection fraction was significant. In our study the sample was patients with BBB but in Vanderbijl study the cases with BBB were excluded from study. Stoichkov et al in 2007 showed that the patients with ventricular arrhythmias had prolonged QT dispersion, greater end diastolic ventricular diameter and lower LVEF than other patients (19).in our study almost in all cases with BBB ,QT dispersion was prolonged So according to Stoichkov study and our results we can concluded that cases with BBB face with increased risk of cardiac arrhythmias. In MESA study for any 10 (m sec) increase in QT interval, incidence of heart failure, cardiovascular events and stroke increased in a follow up of 8 years. And it was found that the prolongation of the QT interval was associated with increased incidence of cardiovascular events in middle to old age cases without previous cardiovascular disease (20).In our study as the above study, prolongation of the QT interval more than 10 (m sec) occurred in both BBB groups. So according to our results and MESA study we can conclude that the cases with prolonged QT interval in our study are associated with an increased risk of cardiovascular events and stroke incidence. In the other study in GREEC in 2013, QT interval was corrected with different equations and was found that at heart rate close to 60 per minute, the results were similar. But there was a difference in the too high or too low rate. The most affected equation from too high heart rate was Bazzet equation(33). In our study as the mentioned study the most affected equation from the heart rate was Bazzet equation. In another study by Talbot et al, was found that there was significant increase in QT interval in cases with BBB especially in cases with LBBB. And this amount in the lower rate is higher. So in this study, proposed that for better estimation of QT interval, the calculated number of QT interval minus 0.07 in LBBB and minus o.o4 in RBBB group be considered (27). As the mentioned study, in our study was found that significant increase in QT interval happens in BBB cases especially in LBBB group. But in our study LVSF was evaluated furthermore. In the other study on 72 patients with different types of IVCD (intra ventricular conduction delay) it was found that QT interval in the RBBB and LBBB is prolonged. and this prolongation was due to QRS prolongation more than J.T interval prolongation(34). In our study as the mentioned study it was found that QT interval in LBBB and RBBB is prolonged. Pai et al in 2002 showed that there was significant association between QT interval and age, heart rate, LV diameters, left atrium diameter, right atrium pressure, QRS duration, LBBB and RBBB, mitral or tricuspid valve regurgitation and also reduced LVEF (26). In our study as the Pai study, was found significant association between QT interval and LVSF. In the Pai study the cases were patients with heart failure, but in our study the cases were patients with BBB with any LVEF. Also in our study unlike the Pai study there was not significant association between age and our variables.

Offers:

1-In another study, QRS and JT intervals be calculated in addition to the QT interval to determine that the QT interval is more affected from which one(34),(35).

2-In addition to these equations (AHA and Bazett) there are other equations that we can corrected QT interval by them in another study and then compare the results to determine that which equation is less affected by the heart rate.

3-In the other design, association between QT interval or QT dispersion with other echocardiographic parameters like as left ventricular diastolic function, right ventricular function,… be evaluated(36).

CONCLUSION

In patients with bundle branch block (BBB) especially LBBB, there is a direct significant relationship between prolonged QT interval and left ventricular ejection fraction (LVEF).So after diagnosis of BBB in ECG, it is better to calculate QT interval until if it is prolonged, evaluation of LVEF with echocardiography was done. On the other hand, QT interval is a diagnostic key for estimation of left ventricular systolic function in patients with BBB.

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