Prolongation of QRS duration and axis deviation in the right bundle branch block are not markers for left ventricular systolic dysfunction

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BACKGROUND: Right bundle branch block (RBBB) is not commonly associated with structural heart disease and left ventricular (LV) systolic dysfunction. The purpose of the present study was to determine whether the QRS duration and degree of right axis deviation (RAD) or left axis deviation (LAD) in patients with RBBB predicted a subset of patients with significant LV systolic dysfunction.

METHODS: In the present prospective study, 75 of 200 consecutive patients with RBBB had their ejection fraction (EF) evaluated by echocardiography. The relationship among QRS duration, axis and EF was derived.

RESULTS: There were no significant differences in sex and EF among the patients with a normal axis, RAD or LAD. The EFs of patients with a normal axis (n=27), RAD (n=15) and LAD (n=33) were

52±15%, 49±14% and 46±17%, respectively (P=0.35). The mean EF (46±16%) of patients with a QRS duration of 150 ms or greater (n=53) was not significantly different from the mean EF (49±18%) of patients with a QRS duration of less than 150 ms (n=22) (P=0.54). For patients with a QRS of 120 ms or greater and less than 150 ms (n=22), QRS of 150 ms or greater and 180 ms or less (n=48), and QRS of greater than 180 ms (n=5), the mean EFs were 49±18%, 47±16% and 44±7%, respectively (P=0.78). There was no significant correlation between QRS duration and EF in all patients (r=0.03, P=0.83), EF and RAD (r=0.38, P=0.16) or EF and LAD (r=0.26, P=0.14).

CONCLUSIONS: In patients with RBBB, the QRS duration and axis do not have a significant relationship with EF. Furthermore, prolongation of the QRS duration (150 ms or greater) in the presence of RBBB is not a marker of significant LV systolic dysfunction.

Key Words: Axis deviation; Ejection fraction; Left ventricular systolic function; QRS duration; Right bundle branch block

Right bundle branch block (RBBB), as opposed to left bundle branch block (LBBB), is not commonly associated with structural heart disease, nor have echocardiographic studies found it to be commonly associated with left ventricular (LV) systolic dysfunction. In the absence of structural heart disease, RBBB has a benign prognostic significance (1). In fact, RBBB was initially thought to be an isolated electrocardiographic phenomenon not associated with any cardiovascular disease. However, RBBB is no longer viewed this way and many epidemiological studies describe its prevalence and long-term morbidity (2-5). More recently, RBBB has been shown to be an important predictor of mortality in heart failure (HF) patients as much as LBBB (6). A prolonged QRS duration alone is an independent predictor of increased total mortality and sudden death in HF patients (7).

In the presence of intraventricular conduction delay, a prolonged QRS duration is also a specific indicator of decreased LV systolic function, and further prolongation of the QRS duration has a higher specificity for decreased LV ejection fraction (EF) (8). RBBB results in a prolonged QRS duration and additionally causes dyssynchrony of LV contraction. Ventricular dyssynchrony reduces LV systolic function and mechanical efficiency (9).

Previous studies (10-12) have suggested a possible benefit of cardiac resynchronization therapy in HF patients with RBBB. Therefore, because of prolongation of the QRS duration and generation of ventricular dyssynchrony, RBBB may potentially be a marker of significant LV systolic dysfunction.

It has been shown that prolongation of the QRS duration in the presence of LBBB is a marker of significant LV systolic dysfunction, but it is not clearly known whether prolongation of the QRS duration (150 ms or greater) in the presence of RBBB is also a marker of significant LV systolic dysfunction (13). It has also been shown that left axis deviation (LAD) in the presence of LBBB does not correlate with EF and does not signify a further decrease in EF (13). However, it is not known whether right axis deviation (RAD) or LAD in the presence of RBBB correlates with EF. The purpose of the present study was to determine whether the QRS duration and degree of RAD or LAD in patients with RBBB predicted a subset of patients with significant LV systolic dysfunction.

METHODS

The present study was approved by the institutional review board of the Downstate Medical Center – State University of

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TABLE 1
Demographic and clinical characteristics (n=75)

Variables	Values
Age, years	68±14
Women, %	55
Mean ejection fraction, %	48±16
Mean QRS duration, ms	153±18
Mean QRS axis, degrees	21±90
Right axis deviation, %	20
Left axis deviation, %	44
Normal axis, %	36

Data presented as mean ± SD unless otherwise indicated

New York (New York, USA) and written consent was obtained from participating subjects. From June 2005 to June 2006, 2000 consecutive patients with 12-lead electrocardiograms were screened. Of these, 200 patients had RBBB and 75 patients had their EF evaluated by echocardiography. Patient demographics including age and sex were collected.

The criterion for RBBB was a QRS duration of 120 ms or greater. Secondary R wave (R') in the right precordial leads with R' greater than initial R, wide S wave in leads I, V₅ and V₆, and secondary ST-T wave changes in leads V₁ to V₃ were supportive findings for RBBB. Normal axis, RAD and LAD were determined using a computer and defined as a QRS axis between -30° and 100°, between 100° and 270°, and between -30° and -90°, respectively (14).

Patients with intraventricular conduction defects, LBBB or pacemaker rhythm were excluded. EF was determined by fractional area change on a Philips SONOS 5500 (Philips Healthcare, USA).

Statistical analysis

The demographic parameters among the patients were analyzed using χ^2 methods. Descriptive statistics were also calculated for each variable (age, sex, EF, QRS duration, normal axis, RAD and LAD). The two-tailed Student's *t* test for equality of means was used to compare age with QRS axis (normal axis, RAD and LAD). Univariate ANOVA using type III sum of squares and χ^2 methods were used to compare relationships among variables (EF, QRS duration, normal axis, RAD, LAD and age). ANCOVA was used to adjust for age when comparing EF with QRS axis. All statistical analyses were achieved using SPSS 16.0 software (SPSS Inc, USA). *P*<0.05 was considered to be statistically significant.

RESULTS

Two hundred patients were found to have RBBB, of which 125 patients did not undergo echocardiography due to lack of clinical indication. Of the 75 patients included in the analysis, two patients had atrial fibrillation and the remaining 73 patients had normal sinus rhythm.

Patient demographic and clinical characteristics are shown in Table 1. The mean (± SD) EF of all patients with RBBB (n=75) was 48±16%. There was no significant difference in sex among the patients with normal axis, RAD or LAD. After age-adjusted analysis, there was also no significant difference in EF among the patients with a normal axis, RAD or LAD. The mean age of all patients with RBBB was 68±14 years. The mean EFs of men (n=34) and women (n=41) were 47% and 49%, respectively (*P*=0.46). The mean EFs of patients with a

normal axis (n=27), RAD (n=15) and LAD (n=33) were 52±15%, 49±14% and 46±17%, respectively (*P*=0.35).

The mean QRS duration of all patients with RBBB was 153±18 ms. Prolonged QRS duration (150 ms or greater) was found in 53 patients. The mean EF (46±16%) of patients with a QRS duration of 150 ms or greater was not significantly different from the mean EF (49±18%) of patients with a QRS duration from 120 ms to less than 150 ms (*P*=0.54). For QRS of 120 ms or greater and less than 150 ms (n=22), QRS of 150 ms or greater and 180 ms or less (n=48), and QRS greater than 180 ms (n=5), the mean EFs were 49±18%, 47±16% and 44±7%, respectively (*P*=0.78).

There was no significant correlation between QRS duration and EF in all patients (*r*=0.03, *P*=0.83). Additionally, no significant correlation was found between EF and RAD (*r*=0.38, *P*=0.16) or EF and LAD (*r*=0.26, *P*=0.14).

DISCUSSION

Normal ventricular depolarization has been well described and involves the interventricular septum, free wall of the right ventricle and free wall of the left ventricle (15). Depolarization of the free wall of the left and right ventricle occurs simultaneously, and in almost opposite directions. In the presence of RBBB, right ventricular free wall depolarization is delayed and occurs after LV free wall depolarization, which results in prolongation of the QRS duration. In the presence of nonspecific intraventricular conduction delay without typical features of bundle branch block, a prolonged QRS duration (greater than 100 ms) is a specific indicator of decreased LV systolic function, and further prolongation of the QRS duration has a higher specificity for decreased LV EF (8). In the presence of LBBB, the QRS duration has a significant inverse relationship with EF and further prolongation of the QRS duration (170 ms or greater) is a marker of significant LV systolic dysfunction (13). However, in our study of patients with RBBB, the QRS duration did not have a significant relationship with EF and further prolongation of the QRS duration (150 ms or greater) in the presence of RBBB was not a marker of significant LV systolic dysfunction.

These results at first appear to underscore the benign nature of RBBB in the general population, as found in previous studies (1,16), and may lead physicians to have a higher threshold for further investigating or referring such patients. However, it is not clear why prolongation of the QRS duration in the presence of RBBB is not a marker of significant LV systolic dysfunction. The abnormal pattern of ventricular depolarization associated with RBBB apparently does not induce or exacerbate LV systolic dysfunction, as found with LBBB (17). A recent study (18) found that RBBB induces less mechanical ventricular dyssynchrony than LBBB, despite similar prolongation of the QRS duration. Less mechanical ventricular dyssynchrony may, therefore, cause less LV systolic dysfunction (9). However, the evidence regarding the effect of RBBB on LV contraction compared with that of LBBB is conflicting. Another recent study (10) found that the degree of LV activation delay is similar between patients with RBBB and LBBB. In that study, the major electrical disorder of both right ventricular and LV activation seen in patients with RBBB correlated well with the more compromised hemodynamic profile and the more severe clinical presentation of these patients compared with patients with LBBB.

The explanation for the conflicting results yielded by these studies that examined the effect of RBBB on LV contraction may be due, in part, to the diverse patterns of RBBB. Variations in RBBB are attributable not only to the degree of conduction delay accounting for prolongation of the QRS duration, but also to the site of block (proximal or distal) and the nature of the defect (functional, necrosis or fibrosis) (15,19,20). In addition, coexisting conditions or associated pathologies that affect conduction patterns can influence the pattern of RBBB. A recent, previously mentioned study (10) suggested that patients with RBBB not only have right-sided disease, but in fact also have diffuse disease of the conduction system and myocardium. This would explain the activation delay of the LV lateral wall noted in the patients with RBBB. The notion of RBBB disguising LBBB has been previously described (21-23). The exact mechanisms underlying the diverse patterns of RBBB are still not well understood. Why prolongation of the QRS duration in the presence of RBBB is not a marker of significant LV systolic dysfunction remains an open question.

Our study also examined the electrical axis of the heart in the presence of RBBB. It has been shown that LAD in the presence of LBBB does not correlate with EF and does not signify a further decrease in EF (13). Likewise, in the present study, RAD or LAD in the presence of RBBB did not correlate with EF.

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CONCLUSION

In patients with RBBB, the QRS duration and axis do not have a significant relationship with EF. Furthermore, prolongation of the QRS duration (150 ms or greater) in the presence of RBBB is not a marker of significant LV systolic dysfunction. Further studies are needed to elucidate these results.