Native and Paced QRS Duration in Right Ventricular Apex Paced Patients

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ABSTRACT

Background: The value between paced QRS duration (pQRSd) and native QRS duration (nQRSd) in paced population has not been compared. The relation between nQRSd and pQRSd remains undefined now.

Methods and Results: A total of 310 right ventricular apex (RVA) paced patients were enrolled. The correlation coefficients between nQRSd and pQRSd to left ventricular (LV) dimensions and ejection fraction (LVEF) were calculated and then compared. The association between pQRSd and nQRSd was examined. pQRSd was better correlated with LVDD, LVDS, and LVEF than nQRSd in all patients or patients with no intraventricular conduction block (NIVCB, n = 136) or complete right bundle-branch block (CRBB, n = 86) (all $P < .01$). pQRSd was positively correlated with nQRSd in NIVCB, CRBB, and complete left bundle-branch block (CLBB, n = 45) patients ($r = 0.408$, 0.465, and 0.766, respectively; all $P < .001$). However, pQRSd was not different between NIVCB, CRBB, and CLBB patients ($P > .05$) after adjusting for LVEF and LV dimensions.

Conclusions: pQRSd is superior to nQRSd in terms of reflecting LV structures and function in RVA-paced patients. Bundle branch block (BBB) has no significant effect on pQRSd and thus further studies are needed to clarify whether BBB is an independent risk factor for the development of heart failure after RVA pacing. (*J Cardiac Fail 2010;16:239–243*)

Key Words: Paced, QRS duration, left ventricular ejection fraction, right ventricular apex.

Patients with ventricular pacing may have 2 kinds of QRS complex: native QRS complex and paced QRS complex. Both native QRS duration (nQRSd) and paced QRS duration (pQRSd) are of clinical significance.[1–13] nQRSd correlates with left ventricular (LV) structures and functions and is an important prognostic predictor in patients with systolic heart failure.[1–5] Previous studies also found that nQRSd was a specific but not sensitive index for detecting LV systolic dysfunction.[6,7] In patients with pacemaker implantation, prolonged baseline pQRSd is associated with higher risk for heart failure (HF).[8–12] Several studies have demonstrated that pQRSd was also correlated with LV structures and functions in ventricular-paced patients.[9,10,13] Our previous study[13] found that pQRSd of 200 ms was a satisfactory cutoff value in terms of sensitivity and specificity for detecting LV systolic dysfunction in right ventricular apex (RVA) paced patients. However, whether pQRSd is superior to nQRSd in terms of reflecting LV structures and function has not been investigated. Moreover, the relation between nQRSd and pQRSd, which was just investigated in one small-scale study,[14] remains undefined. Accordingly, the objectives of the present study were to compare the value for reflecting LV structures and function between pQRSd and nQRSd and to determine the relation between nQRSd and pQRSd in a large RVA-paced patient cohort.

Methods

Patients Selection

Consecutive patients referred to our department for routine pacemaker interrogation from November 2007 to May 2009 were enrolled in study. The inclusion criteria were as follows: the ventricular pacemaker lead should be placed at the RVA; paced QRS complex could be seen in each lead in standard electrocardiography (ECG) for correct pQRSd measurement; patients with

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VVI(R) pacemakers or patients implanted with DDD(R) pacemakers having high or third-degree atrioventricular block; in patients with atrial fibrillation, the heart rate should be well controlled (the resting heart rate <80 beats/min) to avoid the effect of aberrant ventricular conduction on nQRSd; by programming the pacing rate to 35 to 40 beats/min, the native QRS complexes could be recorded in standard ECG, and their morphologies were of the same kind in the same patient. Patients younger than 18 years old or using class I antiarrhythmic drugs or with hyperkalemia or hypokalemia (<3.5 or >5.5 mmol/L) were excluded. The study conformed to the principles outlined in the Declaration of Helsinki. The local ethics committee approved the study and all patients provided written informed consent to participate in the study. According to native QRS complex, patients were divided into no intraventricular conduction block (NIVCB), complete right bundle-branch block (CRBB), complete left bundle-branch block (CLBB), and other QRS configuration subgroups. Only patients with NIVCB or CRBB or CLBB were included the subgroups analysis in the study.

Measurements of QRS Duration and LV Structures and Function

The pacing rate was set at 60 beats/min in all patients. The atrioventricular delay (AVD) in patients with DDD(R) pacemaker implantation was at factory setting (130 to 170 ms). Standard 12-leads ECG was acquired at a paper speed of 50 mm/s and a scale of 10 mm/mV. The pQRSd was defined as the length of time from the beginning of the pacing spike to the end of the QRS complex. To record the native QRS complex in standard ECG, the pacing rate was programmed to 35 to 40 beats/min (patients implanted with DDD pacemaker were programmed to VVI pacing first). pQRSd and nQRSd were measured from the ECG using the widest QRS complex from 12 leads by 1 experienced observer, who was blinded to the clinic and echocardiography data. To assess the intraobserver reproducibility of pQRSd measurement, 120 randomly chosen ECGs (60 recording paced QRS complex and 60 recording native QRS complex) were measured twice. The intraobserver variability of pQRSd and nQRSd was 2.55% and 4.32%, respectively. Echocardiography was performed at commonly ventricular pacing status, with GE Vivid 7 (GE Medical Systems, USA) using 1.7−3.4 MZ probe. LV end-systolic diameter (LVDS) and LV end-diastolic diameter (LVDD) were obtained from parasternal long axis view of LV. LVEF was measured with Simpson's method.

Statistical Analysis

Continuous variable and categorical variables were presented as mean value ± SD and %, respectively. Correlations between 2 variables were assessed by Pearson's correlation coefficient. Correlation coefficients were compared by Steiger's z test.[15] Comparisons of valuables between different subgroups were performed by univariate analysis of variance followed by multiple comparisons corrected by Bonferroni's method. Then an analysis of covariance was used to obtain LVEF, LVDD, and LVDS-adjusted comparisons of pQRSd between different subgroups. $P < .05$ was considered to represent statistical significance. Regarding multicomparisons of correlation coefficient and pQRSd, $P < .01$ was considered to statistically significant to reduce type I error. Statistical analyses were performed using the SPSS 13.0 software package (SPSS, Inc, Chicago, IL).

Results

Patients' Characteristics

From 1124 patients referred to our department for routine pacemaker interrogation, 310 patients who met the inclusion criteria were enrolled in this study. The patients' characteristics were given in Table 1. On the aspect of native QRS complex, 136 patients had NIVCB, 86 had CRBB, 45 had CLBB, 13 had incomplete right bundle-branch block, 8 had incomplete left bundle-branch block, and 21 had unclassified intraventricular conduction block. The nQRSd, pQRSd, LV diameters, and LVEF in NIVCB, CRBB, and CLBB patients were presented in Table 2. The nQRSd and pQRSd were longer, LV diameters greater, and LVEF less in CRBB and CLBB patients than in NIVCB patients (all $P < .05$, Table 2). However, nQRSd, pQRSd, LV diameters, and LVEF were not different between CRBB and CLBB patients (all $P > .05$).

Comparison of Value for Reflecting LV Structures and Function Between pQRSd and nQRSd

Both nQRSd and pQRSd were positively correlated with LVDD and LVDS, and negatively correlated with LVEF in all patients or in the subgroups of patients with NIVCB or CRBB or CLBB (all $P < .01$). However, pQRSd was better correlated with LVDD, LVDS, and LVEF than nQRSd in all patients or subgroups of patients with NIVCB or CRBB ($P < .01$, Table 3). In CLBB patients, pQRSd also better correlated with LVEF than nQRSd ($r = -0.773$ and -0.605, respectively; $P < .001$; Table 3), but the correlations of nQRSd with LVDD and LVDS were not significant different those of pQRSd with LVDD and LVDS ($P > .05$, Table 3). These results suggested that pQRSd was superior to nQRSd overall in terms of reflecting LV structures and function, particularly in NIVCB and CRBB patients.

Table 1. Patients' Characteristics

Patients (n)	310
Age (y)	69.73 ± 12.63
Male/female [n (%)]	200/110 (64.52%/35.48%)
Underlying disease [n (%)]	
Ischemic heart disease	37 (11.94%)
Dilated cardiomyopathy	28 (9.03%)
Hypertrophic cardiomyopathy	15 (4.84%)
Valvular heart disease	28 (9.03%)
Hypertension	139 (44.84%)
Diabetes	26 (8.39%)
Congenital heart disease	6 (1.94%)
No defined cardiovascular diseases	76 (24.52%)
Bradyarrhythmia [n (%)]	
Sick sinus syndrome	102 (32.90%)
Atrioventricular block	141 (45.48%)
Atrial fibrillation with long R-R interval	89 (28.71%)
DDD/VVI (n [%])	75/235 (24.19%/75.81%)
Years of pacing (95% confidence interval)	8.54 ± 5.28

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