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Case Report

Right Bundle Branch Block Like Pattern Recorded in Right Ventricular Endocardial Pacing

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Right bundle branch block (RBBB) pattern recorded during right ventricular (RV) endocardial pacing should be given special attention in terms of safe RV pacing or lead malposition, e.g. left ventricular pacing or coronary venous pacing, even for patients with no symptoms. Paced electrocardiograms from 47 consecutive patients with a pacemaker implanted were studied. Four patients (8.5%) were found to have RBBB pattern recorded in precordial V_1 and V_2 leads in the usual 4^{th} intercostal space. All of these patients showed left bundle branch block (LBBB) pattern in limb leads. When precordial V_1 and V_2 leads in the 5^{th} space were recorded, RBBB pattern changed to LBBB pattern. Biplane chest X-ray film and echocardiogram, especially 3D echo mode, confirmed that tips of pacing leads of the 4 patients were located in the distal RV septum or the apex. RBBB pattern observed during RV endocardial pacing usually represents safe RV endocardial pacing rather than perforation or malposition of pacing leads.
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Key words: EGG, Pacemaker, Lead malposition, Left bundle branch block, Echocardiogram

Introduction

Right ventricular (RV) endocardial pacing is expected to produce an ECG pattern of left bundle branch block (LBBB). It has been reported that when an unusual QRS morphology resembling a pattern of right bundle branch block (RBBB) is found immediately after insertion of a cardiac pacing lead in the ventricle, perforation or malpositioning should be suspected.[1–5] We identified four patients with a permanent cardiac pacemaker whose QRS complexes showed a RBBB pattern, however, there were no clinical, X-ray, and echocadiographic findings to suggest abnormal lead positioning.

Patients and Methods

Twelve-lead electrocardiograms from 47 consecutive patients during permanent RV pacing or dual chamber pacing were reviewed. Forty-three of the 47 patients were found to have a usual morphology resembling a LBBB pattern. Precordial-lead ECGs of the remaining 4 patients showed a RBBB pattern. Three patients out of 4 patients had a VVI pacemaker for chronic atrial fibrillation with slow ventricular response and one had a DDD pacemaker

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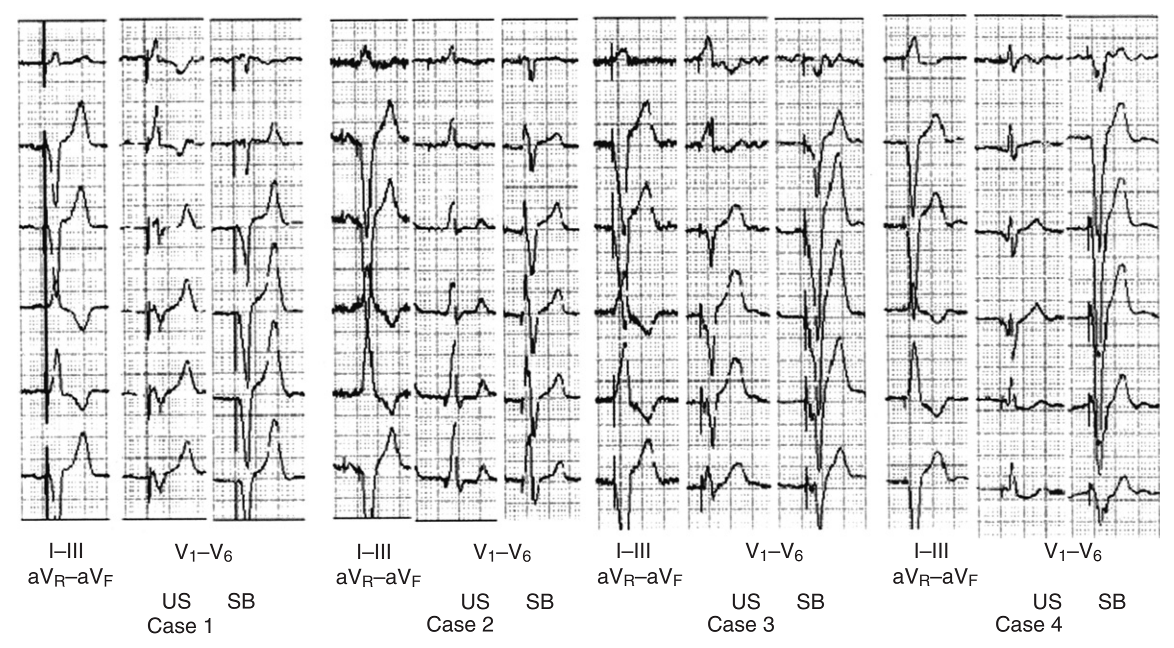

Figure 1 Four 12-lead electrocardiograms from Cases 1–4.
In each case, EGG vertical strips are arranged in order of standard leads, precordial leads in the usual space and precordial leads one intercostal space below the usual space. US = usual space; SB = one intercostal space below

due to sick sinus syndrome. Judging from clinical, electrocardiographic, and echocardiographic observations, there was no possibility that they had serious underlying heart diseases to affect the excitation conduction system. QRS axis deviation, QRS patterns in precordial V_1 and V_2 leads at the level of the usual 4th intercostal space and transitional zone, and those in V_1 and V_2 leads also obtained at the 5th interspace were investigated. Biplane chest X-ray images and echocardiograms were examined to assess ventricular lead location.

Results

Paced electrocardiograms of the 4 patients showed a LBBB pattern with electrical axes whose vector angles were between $-62°$ and $-89°$ in standard leads. Three patients (Cases 1, 3 and 4) had a transitional zone at leads V_2 and V_3 and one (Case 2) had it partially. Precordial leads at the 5th intercostal space showed a LBBB pattern instead of a RBBB pattern which was shown in V_1 and V_2 leads at the usual 4th interspace in all of these patients (**Figure 1**). Chest X-ray images and echocardiograms revealed that the ventricular pacing leads of three patients (Cases 1, 2 and 4) were positioned at distal septum beside the right ventricular apex, while that of the remaining one patient (Case 3) at the apex. In Case 4, the biplane X-ray image showed the lead as if it were located just at the RV apex, but echocardiogram, especially in the three-dimensional echo mode, revealed it was located at the distal septum (**Figure 2, 3**).

Discussion

Our four patients unexpectedly exhibited a RBBB pattern in paced QRS complexes. These patients required careful clinical evaluation. It has been described that ventricular pacing leads were malpositioned mainly into the coronary sinus and rarely into the left ventricle (LV) consequent to perforation through the RV wall or septum. It was reported that accidental LV pacing showed patients had no symptoms. But, once LV pacing was discovered, lead removal or long-term warfarization could be initiated promptly. We carefully assessed lead position in patients whose leads were suspected of malposition with X-ray images and 3D echocardiograms and confirmed all leads of the patients were appropriately positioned in the RV.

RV pacing had been reported to have the possibility of showing a RBBB pattern. Hashiba reported two cases of the RBBB pattern confirming the catheter tip located in the RV apex among 30 pacing events in 16 patients.[6] Ishikawa and Yamagiwa also reported the RBBB pattern in 9 out of 48 patients (18.6%)[7] stating that the left and anterior orientation of the maximal QRS vector may support uncomplicated RV pacing. Kline et al. also identified

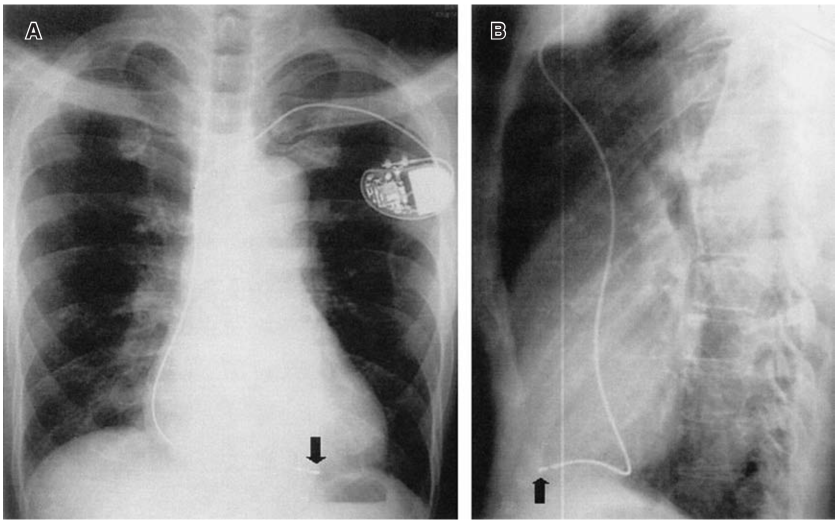

Figure 2 Panel A, posterior-anterior, and Panel B, lateral views of chest X rays from Case 4.
The ventricular lead appears to be placed exactly in right ventricular apex. Black arrow indicates the tip of the ventricular lead.

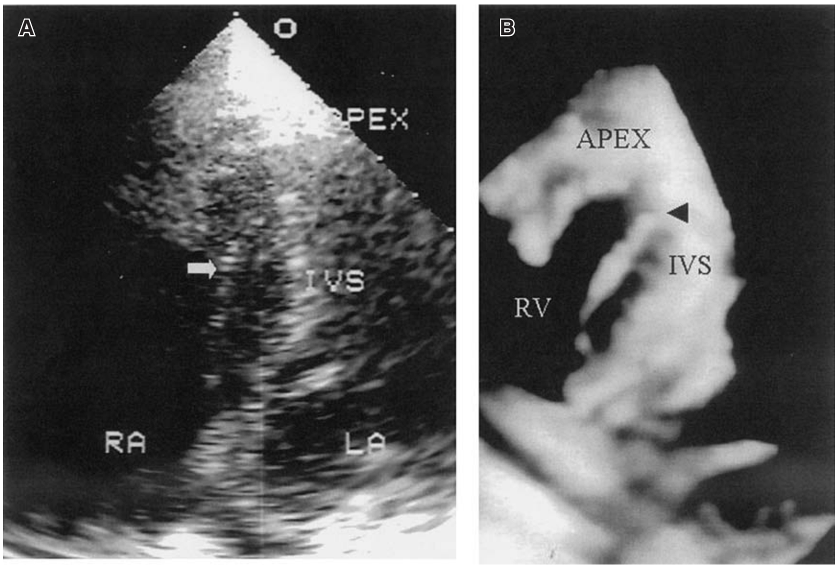

Figure 3 Echocardiogram from Case 4.
The two dimensional mode (Panel A) shows the ventricular lead traveling through the right atrium to the right ventricle in four chamber view, and the three dimensional mode (Panel B) shows the lead tip attaching to the distal septum. White arrow indicates the ventricular lead. Black arrowhead indicates the tip of the ventricular lead.

this pattern in 8 out of 50 patients (16%)[8] and Coman et al. in 14 out of 179 patients (7.8%)[9] which is a similar result to ours (8.5%). Some reports hypothesized that RV pacing stimulated the left ventricle earlier than the right ventricle. Lister et al. reported the numerous pathways from the right ventricle to the left ventricle.[10] Mower et al. described the retrograde conduction through the right bundle branch and down the left bundle branch or the interventricular septum, which may behave electrically as the left ventricle.[11] Barold et al. suggested RV activation delay and early penetration of the electrical impulse into the LV conduction system.[12] However, these hypotheses cannot explain why the LBBB pattern is observed in standard leads when the left ventricle is activated prior to the right ventricle as Kline et al. also described.[8] Our Case 2 patient had preexisting complete RBBB documented on the initial EGG, suggesting RV activation delay before pacing. However, paced QRS showed a LBBB pattern in standard leads and a RBBB pattern in precordial leads in the usual 4th intercostal space which converted to a LBBB pattern in V_1 and V_2 leads at the level of the 5th interspace, revealing that the RBBB pattern was independent of RV activation delay.

Fukatani et al. analyzed the RBBB pattern observed when the RV was definitely paced and suggested that the paced RBBB pattern would occur when the tip of the pacing lead is located at a greater depth from the anterior chest, i.e. close to septum in the RV.[13] They examined two patients with the paced RBBB pattern at autopsy and confirmed that the lead tip was positioned toward the posterior wall at the septum in vicinity of the RV apex.[14] Kline et al. documented that the placement of the precordial lead electrodes influenced the QRS pattern in RV pacing. Placing precordial ECG electrodes in the 5th interspace caused a LBBB pattern, while electrodes at the 3rd space enhanced amplitude of the R wave. Kline et al. named this pseudo RBBB because the RBBB pattern in RV pacing does not represent left prior to right ventricle activation.[8] As for our patients, transfer of precordial leads to the 5th space changed the pattern from RBBB to LBBB. Coman et al. reported four cases in which the RBBB pattern did not change even when V_1 and V_2 electrodes were moved below. All leads of these cases were situated on the mid-septum. Therefore, this technique can distinguish patients with leads located at the mid-septum from those with leads at the distal septum and apex.[9] Yang et al. reported one patient whose RBBB pattern did not change with this technique despite his lead lying in the RV apex.[15] As Ishikawa and Yanagisawa reported in a study of vectorcardiograms, maximal QRS vector is oriented leftward, superiorly and anteriorly in a RBBB pattern produced by RV pacing, whereas maximal QRS vector is directed rightward, inferiorly and posteriorly in a RBBB pattern produced by LV pacing.[7] Coman et al. created an algorithm differentiating RV septum, RV apex, coronary venous, and left ventricular pacing. They suggested that a frontal axis of $0°$–$-90°$ and precordial transition in V_3 could distinguish RV septal and apical pacing from all other forms of LV pacing (including the coronary veins) with 86% sensitivity, 99% specificity, and 95% positive predictive value.[9] In our Case 2 patient, despite lead location at the RV septum, the precordial transition was not found even at a frontal axis of $-82°$. Therefore their criterion could not eliminate the potential of LV pacing.

In conclusion, the majority of RBBB patterns in RV pacing are linked to placement of the precordial lead electrodes irrespective of location of the lead tip. To establish safe RV pacing ruling out LV pacing and coronary venous pacing,[7] the electrocardiographic criteria accompanied with transfer of precordial lead electrodes is useful.[8] However, when lead position can hardly be determined even though applying these criteria, biplane chest X-ray images and echocardiogram, especially 3D echo mode, facilitate to confirm the lead position.

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