

Impact of atrial septal pacing in left ventricular–only pacing in patients with a first-degree atrioventricular block: A case series



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Introduction

Cardiac resynchronization therapy (CRT) is effective in patients with heart failure (HF) and left ventricular (LV) dyssynchrony.¹ However, not all patients respond to CRT. The AdaptivCRT (Medtronic, Minneapolis, MN) algorithm for CRT provides right ventricular (RV) synchronized LV-only pacing when intrinsic atrioventricular (AV) conduction is normal (<220 ms), or, alternatively, biventricular pacing for prolonged AV conduction. AdaptivCRT is effective in patients with normal AV conduction²; therefore, LV-only pacing in patients with prolonged AV conduction is difficult. We report a case series of atrial septal pacing for LV-only pacing in patients with first-degree AV block.

Case report

Case 1

An 80-year-old man with dilated cardiomyopathy complained of dyspnea and was admitted to another hospital for HF. The patient underwent optimal medical therapy and had a New York Heart Association (NYHA) classification of class III. Electrocardiography (ECG) showed complete left bundle branch block (CLBBB) (QRS time, 169 ms). Chest radiography showed a cardiothoracic ratio (CTR) of 53% (Figure 1d). ECG indicated LV dysfunction (LV ejection fraction [LVEF], 20%; LV end-systolic volume [LVESV], 135 mL), and his brain natriuretic peptide (BNP) level was 355 pg/mL. The patient was transferred to our hospital for CRT. We suspected that AdaptivCRT might be appropriate for him; however, he had a first-degree AV block

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KEY TEACHING POINTS

- Left ventricular (LV)–only pacing was performed for patients with prolonged atrioventricular conduction by identifying the atrial pacing site.
- The rate of LV-only pacing is associated with a reduced risk of death or heart failure hospitalization and was higher in patients with normal atrioventricular (AV) conduction time.
- It is essential to identify the adequate atrial pacing site for LV-only pacing in patients with prolonged AV conduction.

(PQ time: 208 ms) (Figure 1a). During CRT implantation, RV and LV leads were positioned at the RV septum and lateral coronary vein, respectively. For right atrial (RA) lead implantation, we explored the RA septum with an AV time <220 ms using a catheter delivery system. The near-coronary sinus ostium (CSOS) and the lower site of the near-AV node had an AV time >50 ms; however, the upper site of the near-AV node had an AV time <200 ms (Figure 2), and the RA lead was positioned. Far-field R-wave sensing presented a permissible range. The pacing QRS width of LV-only pacing was shorter than that of biventricular pacing (Figure 1b and 1c). Six months after CRT implantation in the outpatient clinic, the frequency of total atrial pacing (AP) was 2%, the frequency of all ventricular pacing (VP) was 99.7%, and the frequency of LV-only pacing was 95.9% of VP. NYHA class improved to class I, and the BNP level decreased to 45.5 pg/mL. Furthermore, the CTR of chest radiography recovered to 50% (Figure 1e), and LVEF and LVESV recovered to 49% and 56 mL, respectively.

Case 2

A 65-year-old man had HF and an NYHA classification of class III despite undergoing optimal medical therapy. ECG

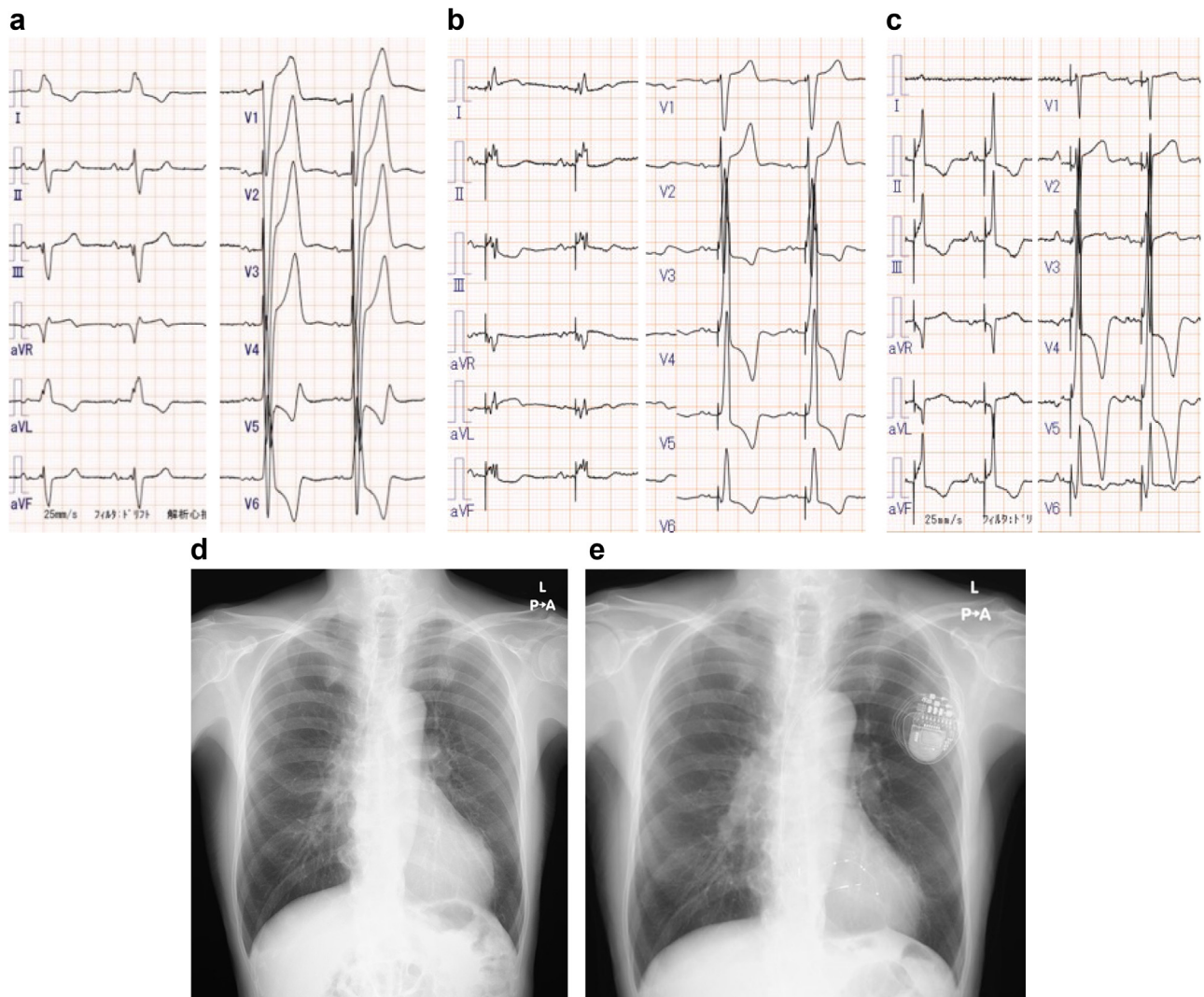


Figure 1 Electrocardiogram and chest radiography of patient in case 1. **a:** First-degree atrioventricular block (PQ time, 208 ms); the QRS time was 169 ms, complete left bundle branch block was present. **b:** After cardiac resynchronization therapy (CRT) with left ventricular-only pacing, the QRS time was 132 ms. **c:** After CRT with biventricular pacing, the QRS time was 166 ms. **d, e:** Chest radiography before and after CRT, respectively.

showed CLBBB (QRS time, 128 ms) and prolonged PQ time (250 ms) (Figure 3a). LVEF and LVESV were 25% and 231 mL, respectively. The BNP level was 448.5 pg/mL, and the CTR of chest radiography was 65% (Figure 3c). During CRT implantation, RV and LV leads were positioned at the RV septum and lateral coronary vein, respectively. The near-CSOS showed the shortest AV time, and the RA lead was positioned. ECG findings showed shortened PQ and QRS time after CRT implantation (Figure 3b). The CTR of chest radiography and the BNP level changed to 57% and 227.9 pg/mL, respectively, 6 months after CRT implantation (Figure 3d). The frequency of total AP was 69.1%, the frequency of all VP was 96.6%, and the frequency of LV-only pacing was 96.4% of VP.

Case 3

An 81-year-old man with a history of coronary artery bypass grafting using an implantable cardioverter-defibrillator was

hospitalized for HF. He underwent optimal medical therapy, and ECG indicated a low LVEF (24%). ECG findings showed AP and ventricular sense waveforms; the PQ time was extremely long (424 ms), and the QRS time was 177 ms (Figure 3e). CRT-defibrillator upgrade implantation was performed. Near-CSOS showed the shortest AV time, and the RA lead was positioned. ECG findings showed shortened PQ (170 ms) and QRS times (146 ms) (Figure 3f). Six months after CRT implantation in the outpatient clinic, the frequency of total AP was 97.4%, the frequency of all VP was 98.4%, and the frequency of LV-only pacing was 97.1% of VP.

Discussion

Determining the appropriate AP site is important for LV-only pacing in patients with prolonged AV conduction; interestingly, this was performed in 3 patients in this study. AdaptiveCRT has an automatic adjustment algorithm for AV and

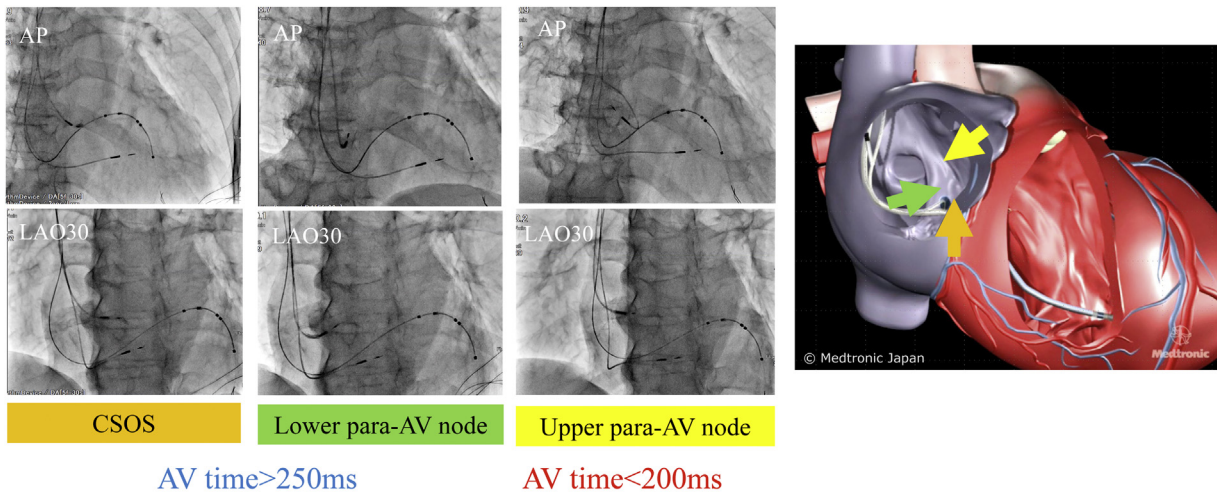


Figure 2 Atrioventricular time of each right atrium (RA) site of patient in case 1 during cardiac resynchronization therapy implantation. The orange arrow indicates coronary sinus ostium (CSOS). The green arrow indicates the lower near-atrioventricular (AV) node. The yellow arrow indicates the upper near-AV node. When the RA lead was on the CSOS and lower near-AV node, the AV time was >250 ms. When the RA lead was on the upper near-AV node, the AV time was <200 ms.

interventricular delays based on frequent AV conduction evaluation, and LV-only pacing is used for normal AV conduction. While CRT commonly uses biventricular pacing, LV-only pacing can be as effective as biventricular pacing.³ A previous report has revealed that AdaptivCRT resulted in fewer HF hospitalizations and lesser cardiac death rates.⁴ Other reports have revealed that AdaptivCRT improved patient survival rates, with a lower incidence of atrial fibrillation.^{5,6} These studies comprised patients with normal AV conduction; therefore, the effect of AdaptivCRT on prolonged PQ time remains unclear. Prolonged PQ time is associated with increased HF hospitalizations or mortality rates among patients undergoing CRT.⁷ Therefore, normal AV conduction may be important for normal CRT and AdaptivCRT, and we recorded normal AV conduction by exploring the AP site.

In our cases, we explored the AP site when AV conduction was normal and we were able to record LV-only pacing. We used a delivery sheath system (C315 delivery catheter C315HIS; Medtronic, Minneapolis, MN) to insert the RA lead (Select Secure lead 3830-69; Medtronic). In all patients, the atrial septum was the most suitable place to insert the RA lead. We do not have detailed echocardiographic data of the mitral flow and the LV wall motion; therefore, the fundamental contribution of atrial and LV pacing remains uncertain. RA septal pacing lends better atrial mechanical function than RA appendage.⁸ Atrial resynchronization pacing, such as dual-site right AP, can improve left atrial function,⁹ and interatrial septal pacing produces a coordinated contraction of the atrium.¹⁰ This effect may have improved HF in the patients in cases 2 and 3, who required AP.

In patients undergoing AdaptivCRT, the rate of LV-only pacing was independently associated with a reduced risk of death and HF hospitalization and was higher in patients with

normal AV conduction time than in those with abnormal AV conduction times.¹¹ RA septal pacing induces a shorter AV interval than right appendage pacing.¹² It is known that shortened QRS time after CRT implantation is associated with favorable clinical and echocardiographic responses.¹³ QRS time was shorter in LV-only pacing than in biventricular pacing in case 1; therefore, LV-only pacing may be favorable in case 1.

Conclusion

Determining the appropriate AP site is important for LV-only pacing in patients with prolonged AV conduction. Atrial septal pacing should be considered as a treatment option for CRT in patients with first-degree AV block.

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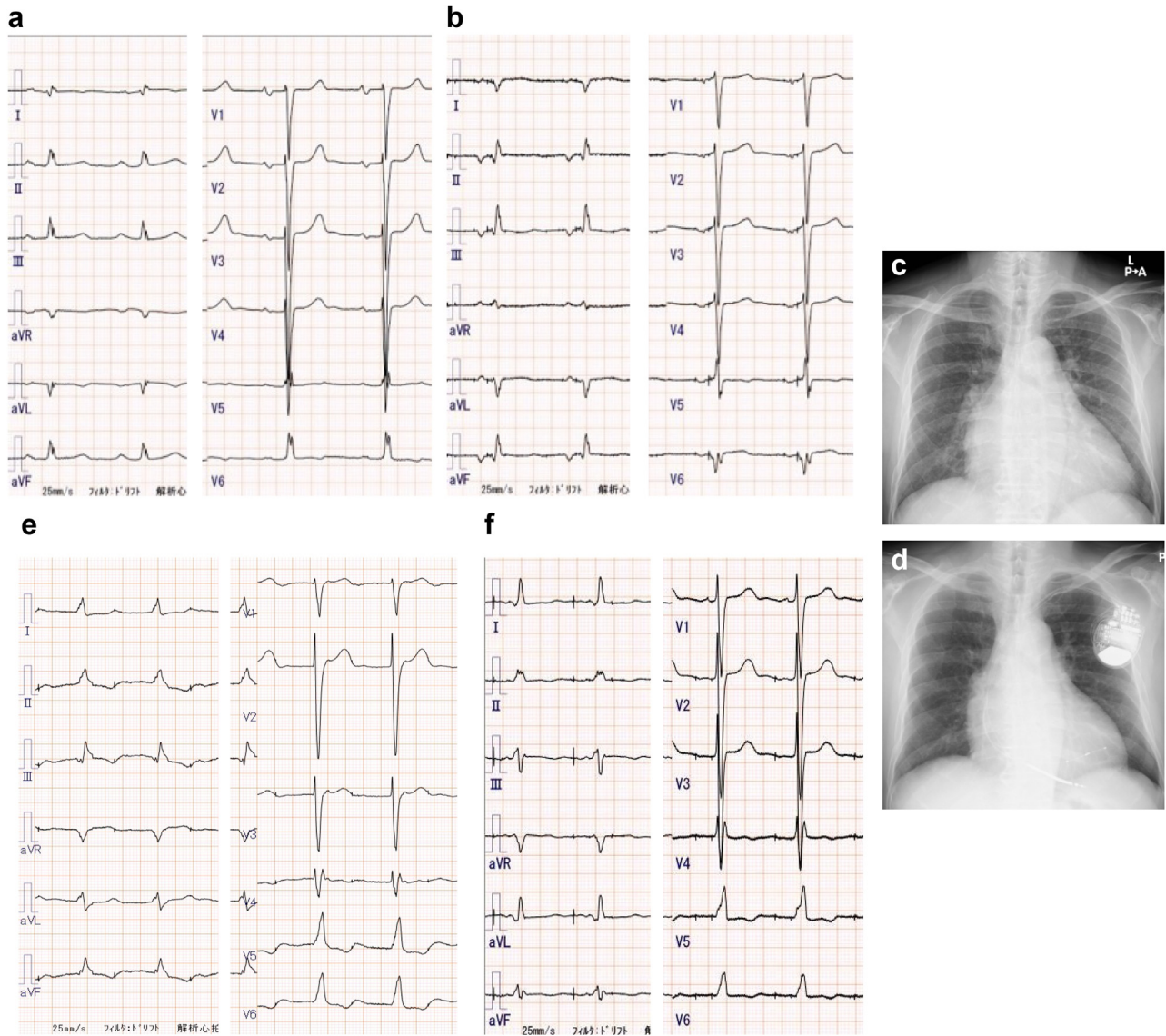


Figure 3 Electrocardiogram (ECG) and chest radiography of patients in cases 2 and 3. **a:** ECG before cardiac resynchronization therapy (CRT) implantation; first-degree atrioventricular block (PQ time, 250 ms), and a complete left bundle branch block (CLBBB) (QRS time, 130 ms) are presented. **b:** ECG after CRT implantation; QRS time is shortened to 123 ms. **c, d:** Chest radiographs before and after CRT, respectively. **e:** ECG before CRT implantation; first-degree AV block (PQ time, 424 ms) and CLBBB (QRS time, 177 ms) are presented. **f:** ECG after implantation; QRS time is shortened to 146 ms.

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