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Letter to the Editor

Effects of cardiac resynchronization therapy on left ventricular mechanical dyssynchrony induced by right ventricular pacing in a patient with heart failure and preserved ejection fraction

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We report a case of refractory heart failure (HF) secondary to right ventricular (RV) pacing-induced mechanical dyssynchrony in an 84-year-old Japanese man with preserved left ventricular (LV) ejection fraction (EF). He was admitted to our hospital for the evaluation and treatment of HF. He had undergone permanent pacemaker implantation with RV apical pacing for atrial fibrillation and bradycardia 6 years ago. He has been receiving optimal medical therapy including beta-blocker, renin–angiotensin–aldosterone inhibitors, and diuretics. However, he was hospitalized twice for worsening HF. He also had multiple episodes of non-sustained ventricular tachycardia in the last 3 months in a local hospital. On admission, he had a New York Heart Association (NYHA) functional class IV HF symptom. Physical examination showed jugular venous dilatation and peripheral edema. Cardiac auscultation showed a grade 4/6 holosystolic murmur at the apex. The electrocardiogram showed ventricular pacemaker rhythm with a QRS duration of 170 ms (Fig. 1A). The echocardiography revealed a distinct LV apical hypertrophy (Fig. 1B), preserved LVEF with 60%, and severe mitral regurgitation (MR) with MR volume and fraction of 68.4 ml and 60%, due to incomplete coaptation of the mitral leaflets (Fig. 2A and B). A two-dimensional speckle-tracking radial strain imaging in the mid-LV short-axis view showed LV mechanical dyssynchrony with septal-to-free delay of 164 ms (Fig. 2C). Coronary angiography revealed only mild coronary artery disease. Hence, we clinically assumed that LV mechanical dyssynchrony secondary to chronic RV apical pacing induces severe MR and refractory HF despite preserved LVEF. To assess the acute effects of biventricular pacing on LV function and MR, we performed pressure–volume loop analysis simultaneously with echocardiography examination. A conductance catheter was placed in the LV, and temporary pacing leads were positioned in the RV apex adjacent to the permanent pacemaker lead and the lateral branch of the coronary sinus. During biventricular pacing, LV stroke work (SW) increased from 3229 to 4641 mm Hg·ml, LV dp/dt increased from 901 to 1146 mm Hg/s, and LV end diastolic pressure decreased from 13.3 to 9.8 mm Hg, respectively (Fig. 3), with a marked reduction in MR assessed using echocardiography, as compared with RV apical pacing. Finally, the patient underwent an upgrade to cardiac resynchronization therapy (CRT) combined with defibrillation (CRT-D) with the lateral LV lead placement, which resulted in the narrowing of the QRS complex to 140 ms. After 1 week of CRT-D implantation, the patient's symptom improved and echocardiography showed a significant reduction in MR (MR volume of 43 ml and fraction of 49%, Fig. 4A and B) and a significant improvement of LV dyssynchrony to only 15 ms (Fig. 4C). The postoperative course was uneventful; the patient was in NYHA class II symptoms and echocardiography showed further reduction in MR (MR volume of 20 ml and fraction of 38%, Fig. 5A and B) at a 3 month follow-up.

RV apical pacing induces abnormal electrical and mechanical activation patterns which can lead to worsening of MR [1]. Indeed, the patient in the present case had septal-to-lateral mechanical delay, which is typical for echocardiographic feature of left bundle branch block (LBBB) in patients with reduced EF [2]. Although the patient had several potential factors or conditions that contribute to refractory HF including LV apical hypertrophy and permanent atrial fibrillation, we clinically assumed that LV mechanical dyssynchrony secondary to chronic RV apical pacing induces severe MR and refractory HF despite preserved EF. There are only several case reports which demonstrated successful biventricular pacing in patients with preserved EF and RV apical pacing-induced MR [3,4]. As the guidelines for the treatment of HF do not recommend CRT

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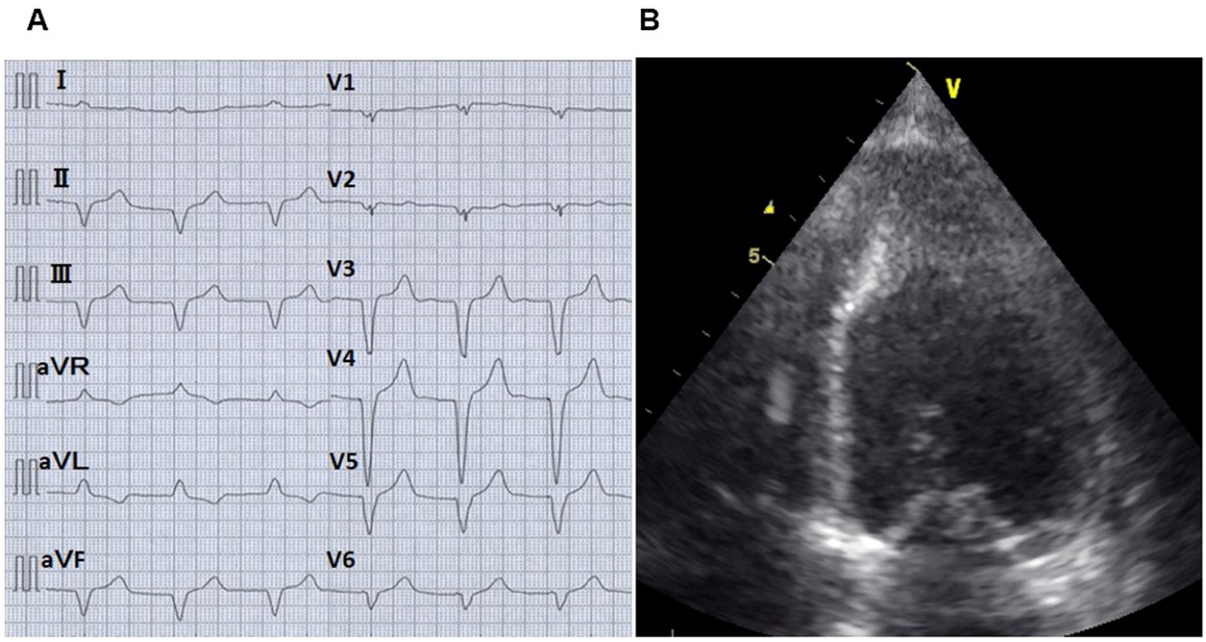

Fig. 1. The electrocardiogram showed ventricular pacing rhythm and left bundle branch block configuration with a QRS duration of 170 ms (A). The echocardiography revealed distinct left ventricular apical hypertrophy (B).

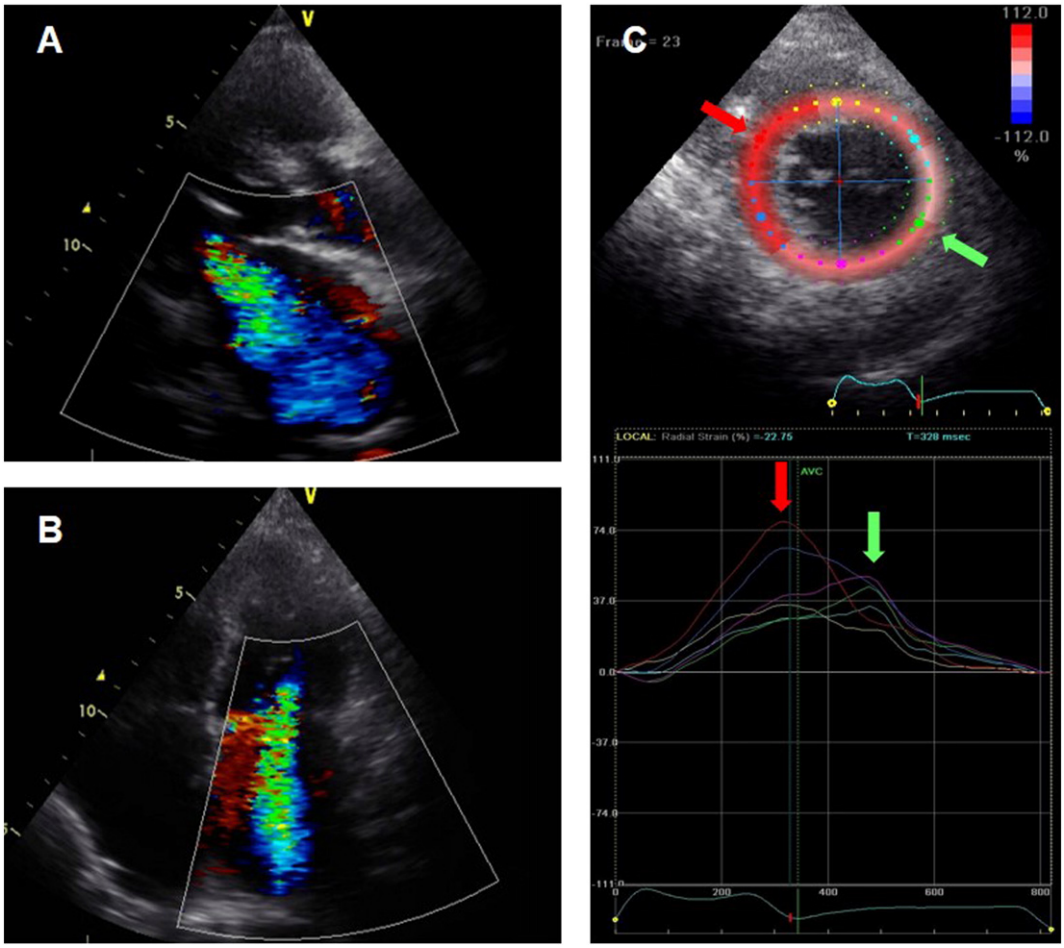

Fig. 2. Color Doppler echocardiography imaging in the parasternal long axis view (A) and the apical four-chamber view (B) showed severe mitral regurgitation. A two-dimensional speckle-tracking radial strain imaging in the mid-LV short-axis view showed left ventricular mechanical dyssynchrony with septal-to-free delay of 164 ms during right ventricular apical pacing (C). Red and green arrows indicate the segments representing the earliest and latest peak systolic strain (upper panel) and corresponding time–strain curves (lower panel) in the 6 segments.