Intentional anodal capture of a left ventricular quadripolar lead enhances resynchronization equally with multipoint pacing

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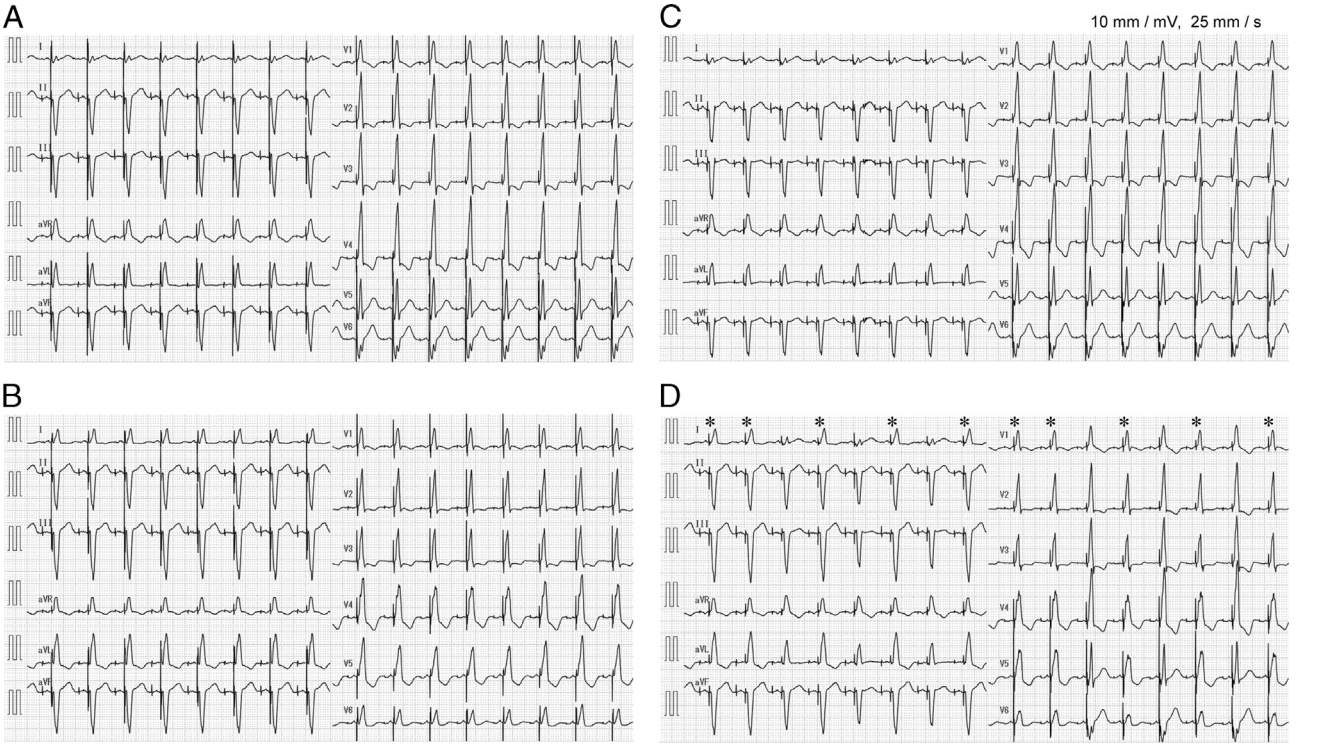

Figure 1 Changes in the 12-lead electrocardiograms (ECGs) during biventricular pacing with different left ventricular (LV) pacing configurations. **A:** Extended bipolar pacing between LV1 and right ventricular coil. **B:** Extended bipolar pacing between LV4 and right ventricular coil. **C:** LV bipolar pacing between LV1 (anode) and LV4 (cathode) with an output of 4.0 V/0.4 ms. The similar morphology to ECG **A** indicates anodal capture. **D:**LV bipolar pacing between LV1 (anode) and LV4 (cathode) with an output of the anodal capture threshold of 3.5 V/0.4 ms. An alternative appearance of ECGs **B** and **C** is shown. The morphology identical to ECG **B** (*asterisks*) indicates a loss of anodal capture.

KEYWORDS Anodal capture; Cardiac resynchronization therapy; Left ventricular pacing; Multipoint pacing; Quadripolar lead

ABBREVIATIONS **CRT** = cardiac resynchronization therapy; **ECG** = electrocardiogram; **LV** = left ventricular; **MPP** = multipoint pacing; **RV** = right ventricular (Heart Rhythm Case Reports 2015;1:386–388)

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Introduction

Left ventricular (LV) multipoint pacing (MPP) using a quadripolar lead appears to confer an incremental hemodynamic benefit over conventional biventricular pacing by capturing a larger area and engaging multiple zones of the left ventricle.[1,2] LV bipolar pacing between the proximal and distal electrodes of the quadripolar lead with intentional anodal capture may theoretically provide an equal effect.

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KEY TEACHING POINTS

- Anodal capture of a quadripolar left ventricular (LV) lead was demonstrated.
- Intentional anodal capture of a quadripolar LV lead may confer an incremental acute hemodynamic benefit over conventional biventricular pacing equal to LV multipoint pacing (MPP).
- Intentional anodal capture of a quadripolar LV lead may be a possible alternative to MPP when cardiac resynchronization therapy effects are suboptimal in patients implanted with a device without an MPP function.

Case Report

A 61-year-old male subject with ischemic cardiomyopathy and status post mitral valve replacement underwent a cardiac resynchronization therapy (CRT) device implantation (sinus rhythm; LV ejection fraction 18%; left bundle branch block; QRS duration 148 ms). The LV quadripolar lead (Attain Performa4298; Medtronic, Inc, Minneapolis, MN) placed in the lateral vein, right atrial lead, and right ventricular (RV) lead were connected to an external pacing system. The acute hemodynamic response (LV *dP/dt* max) to the different pacing modes was assessed with a fixed atrial pacing rate of 100 ppm and an AV delay of 150 ms: AAI 770 mm Hg/s; RV-only pacing, 690 mm Hg/s; RV+LV1 (distal tip) pacing, 900 mm Hg/s; RV+LV4 (the most proximal ring) pacing, 950 mm Hg/s; and RV+LV MPP (unipolar LV1 and unipolar LV4), 1030 mm Hg/s. The LV *dP/dt* max during RV+bipolar LV pacing (LV1 anode, LV4 cathode) with an output of 3.25 V/0.4 ms was 950 mm Hg/s; when the pacing output was increased, it immediately increased to 1040 mm Hg/s with anodal capture at a threshold of 3.50 V/0.4 ms. A decremental pacing output demonstrated an immediate drop in the *dP/dt* max with a loss of anodal capture. Anodal capture was confirmed by the change in the surface 12-lead electrocardiography (Figure 1). Figure 2 shows the acute hemodynamic changes with and without LV anodal capture during biventricular pacing at a pacing output around the capture threshold. Anodal capture was immediately accompanied by a QRS shortening of 20 ms and an 8 mm Hg increase in the LV systolic pressure in addition to the immediate increase in the LV *dP/dt* max.

Discussion

The present case clearly demonstrated that LV bipolar pacing with intentional anodal capture, achieved with a practical pacing output, provided an equal hemodynamic improvement for the MPP delivered from the same electrodes. RV anodal capture through an extended bipolar configuration between the LV cathode and RV ring anode has been well recognized in patients implanted with CRT pacemaker devices. Tamborero et al.[3] reported that in around half of the patients with RV anodal capture, this pacing configuration was associated with the narrowest QRS duration, suggesting its possible hemodynamic benefits. It has been

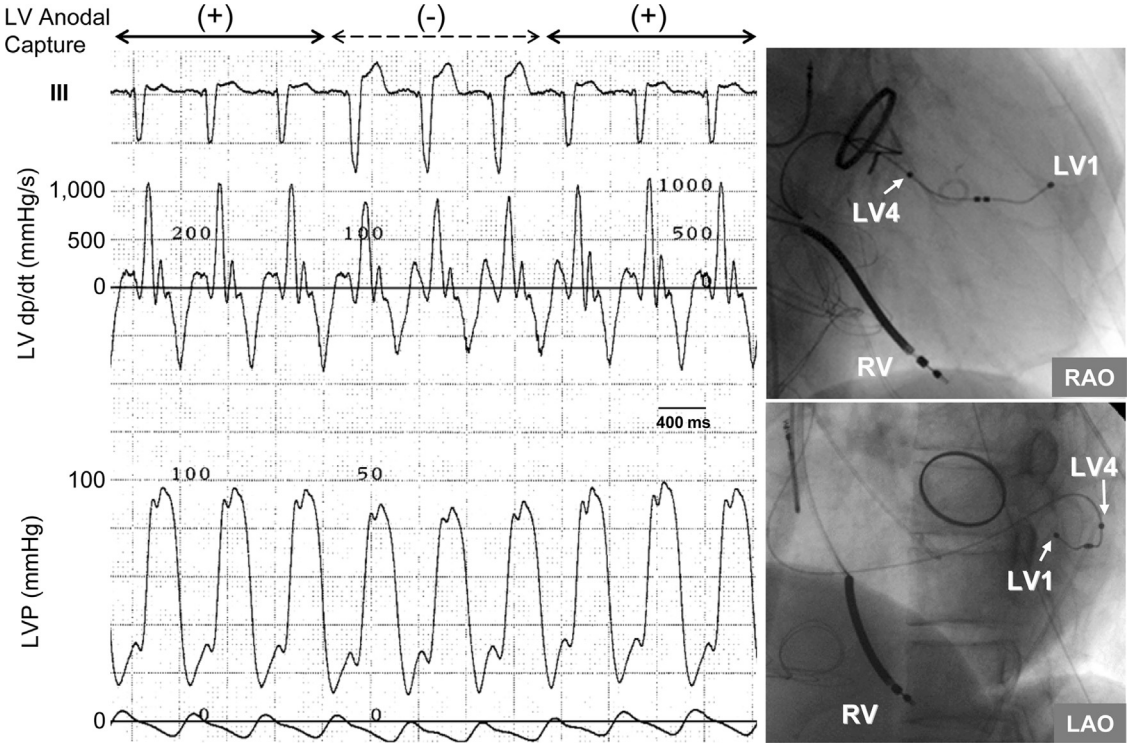

Figure 2 Acute hemodynamic changes with and without left ventricular (LV) anodal capture during biventricular pacing. LV bipolar pacing was performed with LV1 used as the anode and LV4 as the cathode. The LV *dP/dt* max immediately increased with anodal capture and was accompanied by a QRS shortening and increase in the LV systolic pressure. LAO = left anterior oblique; LVP = left ventricular pressure; RAO = right anterior oblique; RV = right ventricle.

hypothesized that 3 wavefronts of ventricular depolarization occur simultaneously from the LV electrode, RV tip electrode, and RV proximal electrode in this setting. The hypothesis can be applied to the anodal capture during LV bipolar pacing. As expected, the present case exhibited hemodynamic benefits of anodal capture comparable to that of MPP.

A drawback of the anodal simulation would be the possible rapid battery depletion when the capture threshold is high. The long-term response to MPP is unknown and the question of whether an acute improvement in the LV *dP/dt* max predicts the long-term clinical benefit is also controversial.

Despite the encouraging recent reports on MPP,[1,2] only limited CRT devices are currently equipped with an MPP function.[1] On the other hand, the quadripolar technology seems to have become the standard for LV pacing. Intentional anodal capture using an LV quadripolar lead may be considered as an alternative to MPP when the CRT effects are suboptimal and the anodal capture threshold is acceptably low.

In conclusion, an intentional anodal capture by the LV quadripolar lead may have an acute hemodynamic benefit equal to LV MPP.

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