

# Response to cardiac resynchronization therapy resulting from an upgrade to dual-site left ventricular pacing

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## Abstract

A 56-year-old man with ischemic dilated cardiomyopathy underwent a secondary prevention biventricular implantable cardioverter defibrillator (ICD) implant. He did not respond symptomatically despite a good radiographic position of the left ventricular (LV) lead. On the basis of an acute hemodynamic study, a second LV lead was implanted, resulting in a good clinical response from dual-site LV pacing.

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## Introduction

Cardiac resynchronization therapy (CRT) has been shown in large randomized trials to confer benefit in both symptoms and prognosis in selected patients with heart failure [1–5]. However, approximately one third of patients do not derive clear clinical benefit (while a similar proportion of matched controls improve without CRT [1]). One reason for this is positioning of the left ventricular (LV) lead in a region of myocardial scar [6–8]. Here we present a case of a patient who did not respond to CRT initially but who improved symptomatically following the implantation of a second LV lead and multi-site LV pacing.

## History

A 56-year-old male presented with a non-ST segment elevation myocardial infarction. Coronary angiography showed occlusions in the left anterior descending and circumflex coronary arteries and a patent right

coronary artery. A delayed enhancement cardiac magnetic resonance imaging (MRI) scan showed significant LV systolic impairment and a complex pattern of largely subendocardial infarction (*Figure 1*).

Left ventricular ejection fraction (LVEF) was 16%. He underwent coronary artery bypass grafting with three saphenous vein grafts. Following a cardiac arrest secondary to ventricular fibrillation one month post-operatively, he received a biventricular implantable cardioverter defibrillator (ICD). When seen in the outpatient clinic two months later, he remained short of breath with minimal exertion, with no improvement since device implantation. He remained on maximal tolerated doses of appropriate heart failure medication. Echocardiographic optimization of atrio-ventricular (AV) and inter-ventricular (VV) delays was performed at one and three months.

At this point the device was delivering biventricular pacing 98% of the time. LVEF was noted to be 18%. However, he remained in New York Heart Association (NYHA) class III. He went on to have assessment with three-dimensional echocardiography, which

## Case report

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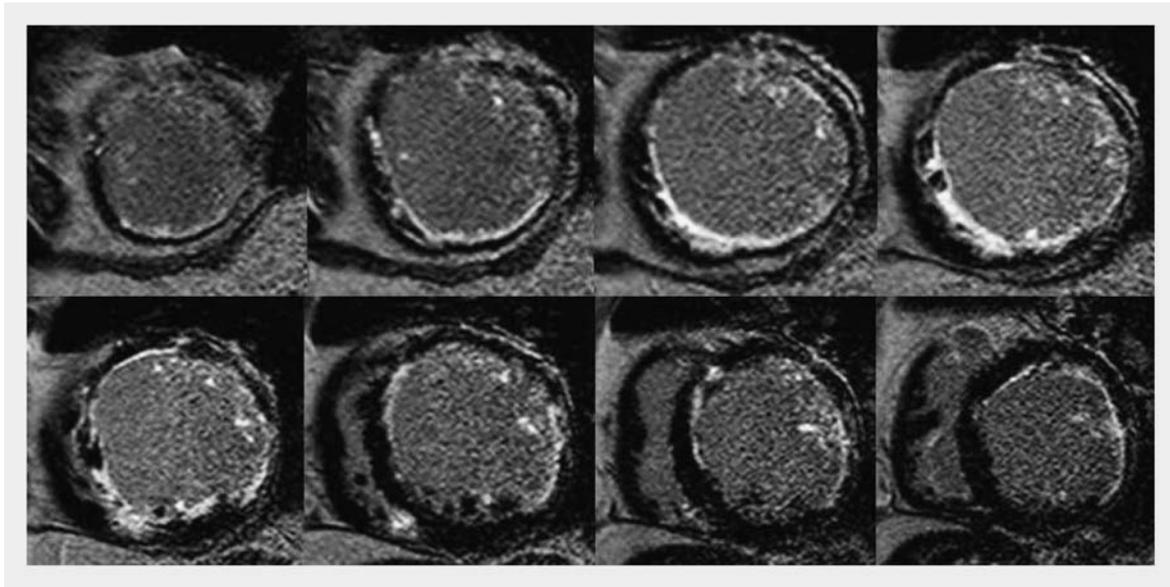


Figure 1. Short axis stack of delayed enhancement cardiac magnetic resonance images from apex (top left) to base (bottom right).

gave a systolic dyssynchrony index of 11%, with basal infero-posterior and lateral LV segments showing the latest volume change. Cardio-pulmonary exercise testing (CPET) was performed and the maximal myocardial oxygen consumption (MVO<sub>2</sub>) was 9.6 ml/kg/minute (41 % predicted). The decision was made to perform an acute hemodynamic assessment with LV stimulation at different sites within the coronary veins, with a view to implant a second LV lead should this give rise to significant acute hemodynamic improvement. This was performed 10 months after the initial CRT defibrillator implant. A Radi™ wire (Radi Medical Systems, Uppsala, Sweden) was passed to the LV cavity using a 5 French femoral arterial sheath. The acute hemodynamic response to different pacing modes is shown in Figure 2.

On the basis of these findings, a second LV lead was implanted in a posterior vein and was connected to a new device along with the existing LV lead using a bifurcating adapter to the LV port (Figure 3).

At six-month review he had improved symptomatically, from NYHA class III to NYHA class II. CPET was repeated with improvement in MVO<sub>2</sub> to 49% predicted. LVEF had improved to 23%.

### Discussion

We have presented a case of a clinical non-responder to CRT who improved following the addition of a second LV lead, in line with the findings of acute hemodynamic assessment. The optimal strategy for clinical non-responders is not clear. Initial steps should ensure: (i) compliance with appropriate heart failure medications and optimization of fluid status,

(ii) exclusion of other conditions that may be underlying symptoms, (iii) optimization of device settings has been performed, and (iv) that a high percentage of biventricular pacing is being delivered.

This case raises several interesting questions. First, why did this patient not respond to CRT? What is the mechanism of benefit from the implantation of a second LV lead? Is this a function of multi-site pacing or has the second lead better avoided the subendocardial scar? Should this approach be considered at the initial procedure? Should it be applied to all non-

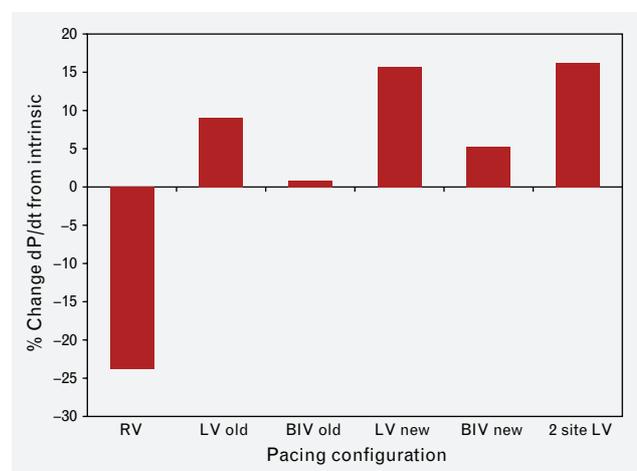


Figure 2. Percentage change in acute hemodynamics from intrinsic rhythm in different pacing configurations. RV right ventricular pacing, LV old pre-existing left ventricular (LV) lead, BIV old conventional cardiac resynchronization therapy (CRT) using previously implanted leads, LV new newly sited LV lead, BIV new conventional CRT using newly sited LV lead, 2 site LV dual-site pacing using old and new LV leads together. All modes used DDD pacing.

## Case report

### *Response to cardiac resynchronization therapy resulting from an upgrade to dual-site left ventricular pacing*

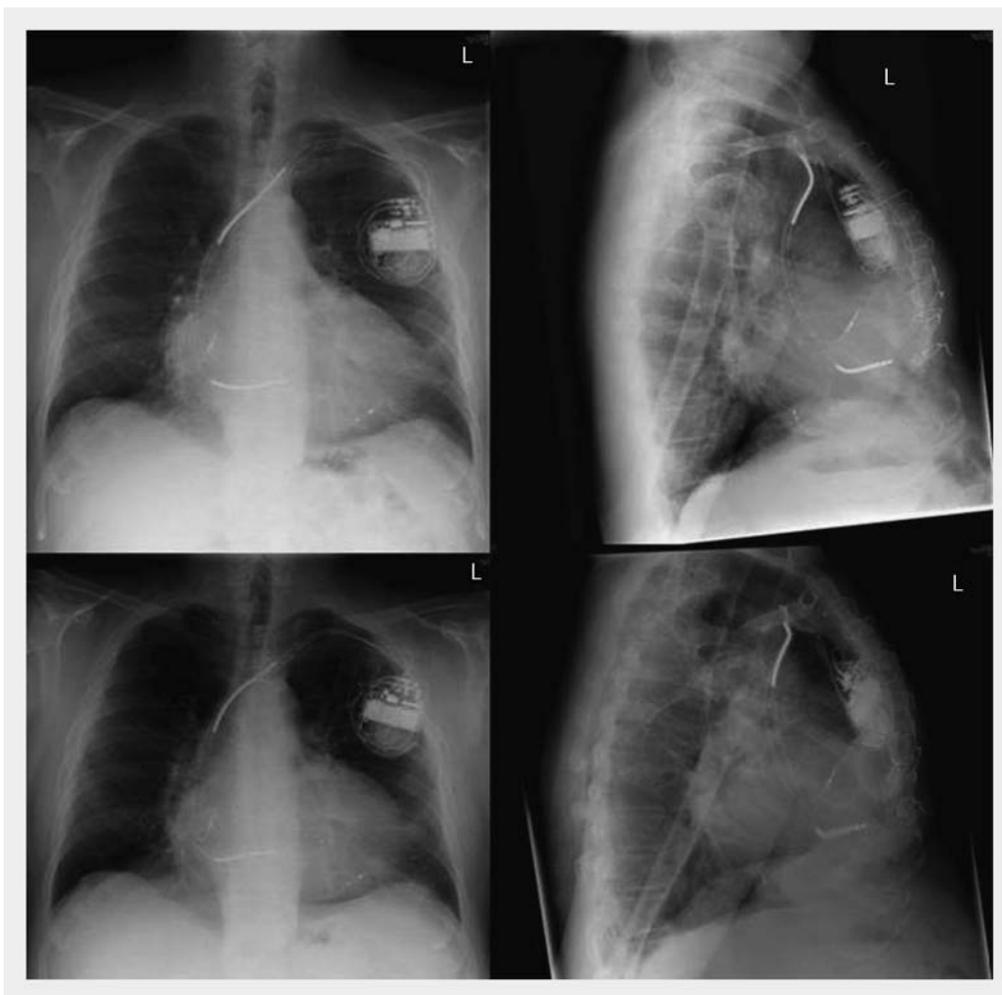


Figure 3. Upper images: Posterior anterior (PA) and lateral chest X-rays of lead positions following initial implant procedure. Lower images: PA and lateral chest X-rays following upgrade with addition of second left ventricular lead.

responders? What is the role of acute hemodynamic assessment?

In this case it appears that the initial LV lead may have been overlying a region of subendocardial scar in the postero-lateral wall. This may not be apparent at the time of the implant procedure, as capture threshold may still be normal. If a lead is overlying an area of subendocardial scar, it may capture but give rise to a lesser degree of clinical benefit. Overlay techniques and image-guided implant technologies are in development and may have a role in the future, to facilitate LV lead delivery away from areas of myocardial scar.

Intuitively, a second LV lead is more likely to be beneficial if the initial lead was not optimally positioned [9]. Multi-site pacing may enable us to pace more effectively around areas of scar. Furthermore, in a dilated left ventricle, it may be that pacing from several different loci will facilitate greater reversal of dyssyn-chrony. However, studies examining the acute hemo-dynamic response to single versus dual-site LV pacing in CRT patients have given conflicting results

[9,10]. Furthermore, despite the fact that acute hemodynamic response has been widely used as a marker of response to CRT, the evidence that this correlates with long-term response is very limited [11].

Two groups have published data regarding long-term response to dual-site LV pacing in CRT. The TRIP-HF study assessed the effects of dual-site LV pacing in patients with atrial fibrillation, diminished LVEF and a bradycardia-related pacing indication [12]. In this cohort, dual-site LV pacing in conjunction with CRT gave rise to significant improvements over conventional CRT in reverse LV remodeling, albeit not in symptomatic response or exercise capacity. Lenarczyk et al. have also shown higher response rates to multi-site LV pacing, but this was not in the form of a randomized trial [13]. The implantation of two LV leads is feasible but technically challenging, and in the case of patients in sinus rhythm necessitates the use of a bifurcating adapter, which leads to elevated capture thresholds [14] and hence reduced device longevity. However, dual-site pacing represents an alternative approach in the context of clinical

non-response to CRT. Alternative strategies include the surgical implantation of an epicardial LV lead via mini-thoracotomy [15], or endocardial LV stimulation via a trans-septal [16,17] or apical approach [18].

## Conclusion

In this case, an upgrade from single-site to dual-site LV pacing resulted in improved clinical response to CRT. This represents one approach to CRT non-responders. Randomized studies are needed to establish the best approach to this challenge. ■

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