Cardiac resynchronization therapy in acute pulmonary edema: A case report

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Abstract
We are reporting a case of 71-year old lady with a dual chamber demand pacemaker, who developed acute pulmonary edema due to an acute left ventricular (LV) dysfunction and worsening in mitral valve regurgitation after atrioventricular nodal ablation for uncontrolled atrial fibrillation. This was attributed to right ventricular apical pacing leading to LV dyssynchronization. Patient dramatically improved within 12-24 h after upgrading her single chamber pacemaker to biventricular pacing. Our case demonstrates that biventricular pacing can be an effective modality of treatment in acute congestive heart failure. In particular, it can be used when it is secondary to left ventricular dysfunction and severe mitral regurgitation attributed to significant dyssynchrony created by right ventricular pacing in patients with atrioventricular (AV) nodal ablation for chronic atrial fibrillation. Our case matches recent update to guidelines that CRT can be useful in patients with atrial fibrillation and left ventricular ejection fraction (LVEF) < 35% if AV nodal ablation will allow ventricular pacing with CRT except our patient has LVEF > 35%.

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Key words: Acute congestive heart failure; Cardiac resynchronization therapy pacemaker; Pacing; Cardiac biventricular pacing

Core tip: Our case demonstrates that biventricular pacing (cardiac resynchronization therapy pacemaker, CRT-P) can be an effective modality of treatment in acute congestive heart failure. In particular, it can be used when it is secondary to left ventricular dysfunction and severe mitral regurgitation attributed to significant dyssynchrony created by right ventricular pacing in patients with atrioventricular (AV) nodal ablation for chronic atrial fibrillation. Our case matches recent update to guidelines that CRT can be useful in patients with atrial fibrillation and left ventricular ejection fraction (LVEF) < 35% if AV nodal ablation will allow ventricular pacing with CRT except our patient has LVEF > 35%.

INTRODUCTION
The detrimental effects of right ventricular apical (RVA) pacing on left ventricular (LV) hemodynamics have been well documented and a higher incidence of heart failure hospitalizations or death in patients with chronic RVA pacing has been attributed to the ventricular dyssynchronization[1,2]. Theoretically, acute RVA pacing could induce discrepancy between electric and mechanical ventricular synchronization resulting in asynchronous left ventricular contraction and relaxation. However, the exact mechanisms of acute LV dysfunction after RVA pacing are not fully understood.

Biventricular pacing (BVP) in chronic heart failure patients within the New York Heart Association (NYHA) functional class III or IV with LV dysfunction and prolonged QRS duration have led to improvement in both
morbidity and mortality. In addition, cardiac resynchronization therapy (CRT) became the innovative treatment of congestive heart failure, and its use has been extended to patients with NYHA functional class I or II.

In our case report, we address the benefit and therapeutic role of CRT pacing in patients who developed acute ventricular dysfunction and worsening in mitral regurgitation due to RVA pacing after atrio-ventricular node ablation for refractory atrial fibrillation.

**CASE REPORT**

A 71-year old woman presented to the emergency department with a chief complaint of worsening dyspnea and orthopnea for three days (NYHA class IV), she had an atrioventricular (AV) nodal ablation for refractory atrial fibrillation five days prior to presentation. Patient had a history of atrial fibrillation, chronic obstructive pulmonary disease, obstructive sleep apnea, chronic kidney disease, primary biliary cirrhosis. She had a history of permanent dual chamber pacemaker that was inserted two years ago for symptomatic bradycardia secondary to sick sinus syndrome after atrial fibrillation cardioversion.

On admission she was orthopneic, tachycardiac and hypoxic that partially improved by using bi-level positive airway pressure. Physical exam revealed positive S1 and S2 heart sounds with a summation gallop, a grade 4/6 apical systolic murmur and a left parasternal systolic murmur that accentuates with inspiration. There was a jugular venous distention up to jaw line. On lung auscultation, there were bibasilar crackles heard. The patient also had bilateral pedal edema. An electrocardiogram (EKG) showed ventricular pacing with a rate of 90 beats per minute (bpm) and QRS duration of 200 ms with positive R in Lead I (Figure 1A). Echocardiographic examination demonstrated decreased left ventricular function (40%), a LV end-diastolic volume (LVEDV) of 97 mL, markedly dilated left atrium (6.1 cm). There were moderate to severe mitral regurgitation (Figure 1B) and moderate to severe tricuspid regurgitation. Pacemaker interrogation showed that the pacemaker was programmed in a DDD mode with lower rate of 60 bpm and upper tracking rate of 120 bpm.

The patient was diagnosed as pulmonary edema and was admitted to the coronary care unit (CCU). She was placed on maximal medical therapy for five days without improvement. Acute ischemic event was ruled out by serial cardiac enzymes. The worsening symptoms and LV dysfunction were attributed to RVA pacing, which then was leading to dyssynchrony and worsening mitral regurgitation.

We decided to upgrade her pacemaker to biventricular (cardiac resynchronization therapy pacemaker, CRT-P), by adding new lead through the coronary sinus to accomplish left ventricular pacing. The old right atrial and right ventricular leads were connected to the CRT pacemaker. Immediately post operatively, the patient reported feeling better and her symptoms improved (NYHA class III). Follow up EKG showed ventricular pacing with a rate of 90 bpm with reduction in QRS duration to 156 ms with negative R in Lead I (Figure 1C). Forty-eight hours after surgery echocardiography demonstrated improvement in LV function (45%) with a reduction in LVEDV to 88 mL and improvement in mitral regurgitation (Figure 1D). The patient was discharged without complication from CCU.

**DISCUSSION**

Since the introduction of cardiac pacing five decades ago

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**Figure 1** Electrocardiogram and echocardiographic examination. A: Twelve lead electrocardiogram after atrioventricular nodal ablation showing pacing rhythm by dual-chamber pacing pacemaker; B: Echocardiography showed moderate to severe mitral regurgitation before cardiac resynchronization therapy pacemaker (CRT-P); C: Twelve lead electrocardiogram after cardiac resynchronization therapy pacemaker; D: Echocardiography showed mild mitral regurgitation after CRT-P.
as an effective treatment for symptomatic bradycardia, scientists have pursued the goal of better approximating the normal cardiac physiology leading to more highly sophisticated devices. BVP has been found to resynchronize ventricular contraction in heart failure patients with wide QRS complexes, leading not only to reversal of LV remodeling over time but also increased functional capacity with an improvement in mortality and quality of life.

The main indication for CRT is congestive heart failure patients with wide QRS and left ventricular dysfunction (ejection fraction ≤ 35%), who are symptomatic even while on maximal medical therapy. Also, CRT can be useful in patients with atrial fibrillation and left ventricular ejection fraction ≤ 35% if AV nodal ablation will allow ventricular pacing with CRT. According to recent guidelines from the European Society of Cardiology, CRT can be an alternative to traditional right ventricular pacing in patients with heart failure and LV dysfunction who have a standard indication for pacing.

Although, biventricular pacing can reverse the dys-synchronization induced by RVA pacing and trials have shown the benefit of biventricular pacing in patients with symptomatic atrial fibrillation after AV nodal ablation. A recent meta-analysis of four trials did not demonstrate improvement in mortality with BVP in comparison with RVA pacing.

Mitrval regurgitation is common in patient with left ventricular dysfunction that negatively affect the survival of patients with congestive heart failure, but CRT has been shown to reduce functional mitral regurgitation by optimizing the force balance acting on the mitral valve.

Our case demonstrates that biventricular pacing (CRT-P) can be an effective modality of treatment of acute congestive heart failure. In particular, it can be used when it is secondary to LV dysfunction and severe mitral regurgitation attributed to significant dysynchrony created by right ventricular pacing in patients with AV nodal ablation for chronic atrial fibrillation.

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