Optimized perioperative biventricular pacing in setting of right heart failure

George Berberian a,*, Joshua P. Kanter b, T. Alexander Quinn c, Henry M. Spotnitz a,1

a Department of Surgery, Columbia University, College of Physicians and Surgeons, 622 West 168th Street, PH 14-103, New York, NY 10032, USA
b Department of Pediatrics, Columbia University, College of Physicians and Surgeons, 622 West 168th Street, PH 14-103, New York, NY 10032, USA
c Biomedical Engineering, Columbia University, College of Physicians and Surgeons, 622 West 168th Street, PH 14-103, New York, NY 10032, USA

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Abstract
Aims A 78-year-old female with prior atrioventricular junctional ablation for paroxysmal atrial fibrillation and implantation of DDDR pacemaker underwent repair of severe tricuspid insufficiency. Effects of biventricular pacing were tested with temporary wires at the conclusion of cardiopulmonary bypass.

Methods An ultrasonic flow probe was placed on the ascending aorta for real time cardiac output measurements. Atrioventricular delay optimization was performed and biventricular pacing was initiated while right–left ventricular delays were varied.

Results There was no advantage of biventricular pacing (optimum right–left ventricular delay of +80 ms) compared with existing DDD.

Conclusions This study confirms the physiological effects of right–left ventricular delay on cardiac output after cardiopulmonary bypass.

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Introduction

A 78-year-old female with a history of paroxysmal atrial fibrillation who had undergone atrioventricular (AV) junctional ablation and implantation of a DDDR pacemaker presented with increasing dyspnoea on exertion and lower extremity swelling with stasis dermatitis over a 6 month period. Transthoracic echocardiography showed severe enlargement of the right atrium (RA) with severe tricuspid insufficiency (TI), dilatation of the inferior vena cava, and a normal left ventricular ejection fraction of 57%. Cardiac catheterization showed normal coronary arteries with elevated RA pressures (22/34, mean 24 mmHg), right ventricular (RV) pressures of 39/14, mean 22 mmHg, pulmonary artery pressures of 40/15, mean 31 mmHg, mean wedge pressure of 24 mmHg, and a low cardiac index (CI) of 1.28 L/min/m².

The patient underwent tricuspid valve repair, restoration of normal sinus rhythm with a maze procedure, and left atrial appendectomy. Because laboratory and clinical data suggested that this patient might benefit from conversion to permanent biventricular pacing (BiVP), the benefits of temporary BiVP were tested after cardiopulmonary bypass (CPB)

Methods

Prior to separation from CPB, the patient’s permanent pacemaker was interrogated and set at VVI with a rate of 60. Standard bipolar wires were sewn in to the RA, anterior wall of RV, and obtuse margin of the left ventricle (LV). An appropriately sized transit-time ultrasonic flow probe (Transonic Systems Inc.) was placed on the ascending aorta. Data acquisition was initiated within 5 min following separation from CPB after volume loading and pressor support with noradrenaline had been optimized. During the period of data acquisition, there were no changes in the amount of pressor support. During atrial synchronous RV pacing, AV delay (AVD) was increased by 30 ms increments from 90 ms to 270 ms, and then decreased incrementally to 90 ms. Effects on cardiac output (CO) were measured during 10-s intervals. At optimum AVD (150 ms), BiVP was initiated. RV–LV delay (RLD) was decreased in 20 ms steps from +80 ms (RV first) to −80 ms (LV first), and then increased in similar steps back to +80 ms.

Results

At the conclusion of testing, we found that RV pacing first (RLD = +80 ms) was optimal (CI = 2.4 L/min/m², Fig. 1). LV pacing first (RLD = −60 ms) resulted in the lowest CI (1.9 L/min/m²). As there was no clear advantage of BiVP with RLD of +80 ms compared with existing DDD pacing through permanent RA and RV leads over longer 30 s intervals (CI = 2.4 L/min/m² for both), her pacing system was left intact.

Discussion

Clinical trials suggest that BiVP can be beneficial for patients with congestive heart failure (CHF), reduced ejection fraction, and ventricular conduction delays [4,5]. Many mechanisms have been proposed to account for the benefit of BiVP. To our knowledge, there are no specific clinical studies addressing the concern that pacing optimization might be specific to particular forms of pathological ventricular loading in acquired heart disease. Rabkin et al. [1] found in a swine model of acute CHF that during pulmonary stenosis and heart block, CO was optimized with RV pacing first (RLD = +40 ms). Understanding the effects of optimization of AVD and RLD may be crucial in understanding the beneficial mechanisms of BiVP and developing guidelines for perioperative BiVP. This report demonstrates that RLD optimization affects CO measurements after CPB and open-heart surgery. Results also suggest that beat-to-beat measurement of CO is useful in real time for BiVP
optimization. BiVP with RV pacing first (RLD = +80 ms) did not offer a major benefit over standard DDD pacing in this patient with severe right heart failure. The patient suffered from RV dysfunction with volume overload due to severe TI and heart block, which may have led to RV excitation delay. This cannot be confirmed in the presence of heart block. The benefit of BiVP with RV pacing first or standard DDD pacing may reflect the dependence of overall cardiac function on the RV in this patient. It is important to note that the data for this study were obtained shortly after weaning from CPB and that RV dysfunction could have potentially been aggravated by CPB and hypothermia. This suggests that different pacemaker settings might be optimal for this patient in the long run. Optimized BiVP may be beneficial in other forms of pathological ventricular loading. Further clinical studies are indicated to assess potential benefit.

References