EDITORIAL COMMENTARY

Iatrogenic ventricular dyssynchrony: A preventable cause of heart failure with right ventricular pacing?

Ron D.B. Simon, MD, Scott W. Burke, MD, Michael R. Gold, MD, PhD

From the Division of Cardiology and Heart & Vascular Center, Medical University of South Carolina, Charleston, South Carolina.

Few therapies in arrhythmia management have undergone as dramatic a change in clinical utility as right ventricular pacing. Initially, pacemakers were developed to treat complete heart block following surgery for congenital heart disease. This was lifesaving therapy that quickly spawned a highly competitive industry that included more than a dozen companies developing this new technology. An engineering breakthrough and major advance in this field was the development of dual-chamber pacemakers to allow for “physiologic” cardiac activation. Retrospective studies reported dramatic reductions in mortality, stroke, congestive heart failure (CHF), and arrhythmias with dual-chamber pacing compared with ventricular pacing. However, large prospective randomized studies failed to substantiate these claims, demonstrating less pacemaker syndrome and a modest reduction of atrial fibrillation, but no clear impact on mortality, stroke, or cardiovascular morbidity. Interestingly, studies of atrial pacing alone, a modality rarely used in the United States, demonstrated superior outcomes compared with either ventricular or dual-chamber pacemakers, one of the early indicators of the problems associated with right ventricular pacing.

Patients with CHF were thought to be a group who benefited the most from appropriately timed right ventricular pacing. Observational studies reported marked improvement in functional status and ejection fraction with dual-chamber pacing incorporating a short (100-ms) AV delay. Subsequent randomized controlled studies again failed to confirm the benefit of right ventricular pacing. In fact, the Dual Chamber and VVI Implantable Defibrillator (DAVID) trial showed that dual-chamber pacing caused increased mortality and hospitalizations for CHF in a cohort with left ventricular systolic dysfunction but no standard pacing indication. The pathophysiologic processes causing these findings likely are multifactorial. Right ventricular apical pacing produces paradoxical septal motion and interferes with the normal functioning of the mitral apparatus, potentially causing mitral insufficiency. Right ventricular pacing also affects diastolic function, as diastolic filling times are diminished. In addition, there are important metabolic effects of such pacing, including changes in regional myocardial blood flow and perfusion. Pacing from the apex increases serum catecholamine levels that could have deleterious long-term effects on functional status and survival. Finally, atrial (AAI) pacing in patients with intact AV conduction produces a higher cardiac output than dual-chamber pacing or ventricular pacing, indicating the ventricular activation pattern may influence cardiac performance.

Given the accumulating data indicating the deleterious effects of right ventricular pacing, particularly from the apex, alternative pacing sites were evaluated. Most commonly, pacing from the right ventricular septum or outflow tract was investigated. Acute hemodynamic studies showed no hemodynamic benefit of pacing from these alternative sites among patients with CHF. Moreover, comparative studies of apical and outflow tract pacing also failed to show improvements in functional status, exercise times, or quality of life. A small randomized study of apical vs septal pacing suggested that there are less deleterious perfusion and structural effects with septal pacing, but that this difference took more than 1 year to manifest. Interestingly, Schwaab et al demonstrated that pacing in the right ventricle with the shortest paced QRS duration, regardless of the site, was associated with the best hemodynamic response.

In this issue of Heart Rhythm, Shukla et al measured the baseline and paced QRS durations in 1,026 patients from the Mode Selection Trial (MOST). They observed that among patients with sinus node dysfunction and preserved left ventricular function, increasing paced QRS duration incrementally increases the risk of heart failure hospitalization. Importantly, this risk was shown over a median follow-up of 33 months. The study is limited by the fact that only patients exhibiting pacing on a 12-lead ECG were included, introducing selection bias of patients who had a high percentage of ventricular pacing. Consequently, this analysis may not apply to patients who pace infrequently in the ventricle. Nonetheless, this analysis shows once again that right ventricular pacing is detrimental to cardiac performance, even among patients without a history of CHF or left ventricular dysfunction.

Address reprint requests and correspondence: Dr. Michael R. Gold, Division of Cardiology, Medical University of South Carolina, 135 Rutledge Avenue, Suite 1201, Charleston, South Carolina 29425.

E-mail address: goldmr@musc.edu.
As we have now learned, right ventricular pacing is far from physiologic. Such pacing causes dyssynchronous activation of the left ventricle and mimics a left bundle branch block in many ways. It clearly should be avoided when possible. Programming long AV delays, activating features that promote intrinsic conduction by automatically increasing the AV delay, or using AAI mode are important interventions in patients with pacemakers or implantable cardioverter-defibrillators. The Post AV Node Ablation Evaluation (PAVE) trial showed that biventricular pacing is superior to right ventricular pacing among pacing-dependent subjects, particularly when left ventricular systolic dysfunction is present. Clearly, we have come a long way from the unbridled enthusiasm for the development of dual-chamber pacemakers to the philosophy of avoiding right ventricular pacing at all costs. Such a dramatic transition highlights the importance of controlled clinical studies rather than technologic achievements to guide clinical practice.

References