Right ventricular pacing: the best site is yet to be defined

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The right ventricular (RV) apex is the traditional site to provide stable and reliable chronic ventricular pacing. Interest in alternate site pacing has grown since RV apical pacing has been associated with increased mortality and morbidity compared to normal atrio-ventricular conduction.1-4 Alternate pacing sites include the RV septum and outflow tract.

Chronic pacing from RV apex causes abnormal ventricular activation and results in asynchronous left ventricular (LV) contraction and relaxation. Subsequent left ventricular structural and mechanical remodeling occurs that might explain the increased mortality and morbidity.5-9

The search for alternate pacing sites started several decades ago. No large scale, randomized, double-blind clinical trial shows one pacing site to be superior to another. The heterogeneity of alternate pacing sites between studies contributes to an inconclusive picture. In a recent review,10 de Cock et al analyzed nine reports on over 227 patients. Three of nine studies favored RV outflow tract pacing; six did not.

In 1996, Giudici11 performed a non-randomized study of 89 patients. Most patients were paced from the RV apex followed by the RV outflow tract through active-fixture leads placed at both sites. Acute aortic Doppler flow measurements showed that cardiac output improved by 18.9% (and cardiac index by 21.0%) with RV outflow tract pacing compared to RV apical pacing. Patients with the lowest baseline cardiac index had the greatest improvement. This study was criticized for possible bias and for the extent of improvements.12

In another study,13 twelve patients who underwent AV nodal ablation for uncontrolled atrial fibrillation and rapid ventricular response received two ventricular leads. One was implanted in the RV apex and the other in RV outflow tract. The apical lead connected to the ventricular port and the outflow tract lead was connected to the atrial port. The pacing site was switched by programming the pacemaker in a randomized crossover design. Left ventricular function was assessed by echocardiography and radionuclide ventriculography after 2 months of pacing at each site. The RV outflow tract pacing resulted in significant increase of fractional shortening (0.31 ± 0.05 vs 0.26 ± 0.07) and resting (but not during exercise) ejection fraction (0.51 ± 0.14 vs 0.43 ± 0.10). Study results were questioned for the absence of a lead-in phase for the recovery from tachycardia-induced cardiomyopathy.14

Victor et al14 evaluated 16 patients with AV block who had persistent atrial fibrillation and flutter. Using a blind crossover design, 16 patients with left ventricular ejection fraction >0.40 (n=10) or <0.40 (n=6) were evaluated by pacing site (RV apex or RV outflow tract). NYHA functional class, left ventricular ejection fraction, exercise time and myocardial oxygen demand did not differ by pacing site.

In a recent randomized, cross-over trial (the ROVA Trial),15 Stambler et al evaluated whether quality-of-life is better with RV outflow tract or RV apical pacing in 103 pacemaker recipients with evidence for heart failure, left ventricular systolic dysfunction (left ventricular ejection fraction <0.40) and chronic atrial fibrillation (AF). After 12 months, quality-of-life scores between phases of different pacing sites did not differ. The left ventricular ejection fraction was higher (P = 0.04) in those assigned to RV apical rather than RV outflow tract pacing between months 6 and 9.

Schwab16 evaluated outcomes in patients paced from the RV apex and RV outflow tract. Left ventricular function was more a function of total QRS duration during pacing than site of pacing. The QRS was narrower with septal vs. apical pacing in 9 of 14 but wider in 4 patients. There was no difference in 1 patient.

In this current issue, Hua et al compared hemodynamic parameters at the time of implantation by echocardiography during RV apical pacing to those during RV septal pacing in 10 subjects with chronic atrial fibrillation and slow ventricular rate. The mean left ventricular ejection fraction was 0.62 although some patients were thought to have evidence for congestive heart failure. The authors found that the left ventricular ejection fraction, fractional shortening and stroke volume were reduced with RV apical pacing but not with RV septal pacing.

The study results are confounded by several issues: 1) The order of measurements (apical then septal) may bias results. The pacing order is not randomized or blinded. 2) It is unclear whether the pacing rate between the two sites was comparable but this is important since the measured parameters are pre-load dependent. 3) Fractional shortening measurements by M-mode echocardiography may be influenced by septal motion and not necessarily reflect global left ventricular function, nor reflect differences due to the pacing site.

One thing is clear: it is better not to pace from the right ventricle at all unless necessary. For sinus node dysfunction, outcomes are better with atrial based pacing as long as AV nodal and bundle conduction is intact.17-19

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Several small inconclusive studies show benefit pacing from one site or another in the right ventricle. Not one is definitive. The optimal pacing site remains to be determined and may differ depending on the patient. It is possible that left ventricular pacing alone is superior to RV pacing from any site.

We enthusiastically await results from large, randomized, blinded, multicenter trials that provide clear definition of the risks and benefits of pacing from one ventricular site or another.

References


