Cardiac Pacing

An Alternative Treatment for Selected Patients With Hypertrophic Cardiomyopathy and Adjunctive Therapy for Certain Patients With Dilated Cardiomyopathy

Robert A. O'Rourke, MD

The use of pacemaker technology for treating cardiomyopathies has provoked keen interest and enthusiastic support in the past decade. Often, the hemodynamic abnormalities associated with heart disease can be modified, at least for the short term, by altering the timing, sequence, and site of cardiac electrical activation. In both hypertrophic cardiomyopathy and dilated cardiomyopathy, dual-chamber pacing has relieved symptoms and improved hemodynamics in certain patients. However, pacing techniques should be used as a therapeutic approach to individual patients rather than as routine therapy for most patients with cardiomyopathies. Only recently have controlled, randomized studies assessed the usefulness of dual-chamber (VDD and DDD) pacing in patients with hypertrophic or dilated cardiomyopathies.

Pacing for Hypertensive Hypertrophy With Cavity Obliteration

As reported in this issue of Circulation, Kass and associates implanted dual-chamber pacemakers (VDD) in 9 patients with exertional dyspnea attributed to hypertensive left ventricular (LV) hypertrophy with supranormal systolic ejection (mean ejection fraction 85%) and distal cavity obliteration (hypertensive hypertrophy with cavity obliteration; HHCO). In this small number of patients, intrinsic atrial rate was sensed and ventricular preactivation achieved by shortening the atrial-ventricular (AV) delay.

All patients had concentric hypertrophy with markedly increased septal and LV free-wall thickness, no systolic anterior motion of the mitral valve, and an intracavitary pressure gradient between distal and basal LV regions.

VDD pacing was randomized to “on” or “off” for 3-month periods followed by 6 additional pacing “on” months. With pacing on, exercise duration rose by an average of 82% and maximum oxygen consumption increased 24% above that measured when pacing was off. Improved exercise capacity persisted at 1 year (pacer on). Clinical symptoms and dobutamine-stimulated systemic reserve (stroke volume and cardiac output) increased when pacing was on.

At 1-year follow-up, resting echocardiographic/Doppler data showed a modest but significant increase in LV diameter and a decline in average midwall thickness. LV wall mass declined by an average of 6.4%. Diastolic function as assessed by Doppler measurements of LV filling was unchanged. This study indicates that VVD pacing may provide alternative therapy for selected patients with HHCO by causing discordant contraction and inhibiting cavity obliteration by increasing end-systolic volume.

Pacing for Hypertrophic Obstructive Cardiomyopathy

The first large series of patients undergoing pacing for hypertrophic obstructive cardiomyopathy (HOCM) was reported by Duck et al in 1984. Asynchronous ventricular stimulation, triggered by sensing a native atrial activation, and synchronous dual-chamber pacing modes were investigated in a selected group of 23 patients with LV outflow gradients of ≥30 mm Hg. With either pacing mode, significant outflow gradient reductions occurred in all but 1 patient. The optimal AV delay for maximum gradient reduction varied between 5 and 20 ms.

In 1992, Jeanrenaud et al assessed the short- and long-term effects of dual-chamber pacing in patients with HOCM who had symptoms despite medical therapy. A significant reduction in the peak LV outflow pressure gradient occurred in 12 of the 13 patients during DDD pacing at the optimal delay compared with atrial pacing (47±34 versus 82±42 mm Hg; P<0.002). In the same year, Fananapazir and associates studied 44 consecutive patients with HOCM and symptoms despite medical therapy before and 1.5 to 3 months after DDD pacemaker implantation. The pacemaker was programmed with the longest AV delay that allowed maximal ventricular preexcitation. Symptoms, exercise duration, and outflow pressure gradients were all improved at follow-up evaluation. The authors concluded that “DDD pacing should be tried in all patients with obstructive hypertrophic cardiomyopathy in whom symptoms have not responded to pharmacotherapy before considering LV septal myectomy or mitral valve replacement.”

In a subsequent report by Fananapazir et al, 84 patients with HOCM underwent follow-up of 2.3±0.8 years after the onset of DDD pacing. Symptoms were eliminated or improved in all but 8% of the patients. In a subgroup of 48
patients who had suitable serial echocardiographic examinations, DDD was associated with a reduction in LV wall thickness of ≥4 mm in 11 patients. However, reprogramming of the pacemaker often was required to ensure septal preexcitation or improve chronotropic response to exercise. Chronic atrial fibrillation developed in 7 patients, and radiofrequency ablation was used in 15% of cases. A European multicenter clinical study also showed a significant reduction in LV outflow tract gradient with DDD pacing but a less-impressive improvement in metabolic exercise testing. There was no correlation between the extent of gradient reduction and symptomatic improvement.

The precise mechanism by which pacing reduces LV outflow gradient and/or improves symptoms in HOCM remains controversial. The mechanisms invoked include asynchronous ventricular activation, paradoxical septal motion, a negative inotropic effect, an increase in end-systolic volume, decreased mitral valve systolic anterior motion, altered myocardial perfusion, and regression of LV hypertrophy. The selection of an optimal AV interval for long-term pacing is essential. This delay must be sufficiently short to guarantee early right ventricular apical activation without conduction through the native His-Purkinje system. However, if the AV delay is too short, a marked elevation in mean left atrial pressure may occur despite a reduced outflow tract gradient. AV nodal blocking drugs are frequently necessary to maximize pacing conditions, and AV nodal ablation in conjunction with rate-responsive pacing is recommended for patients with chronic atrial fibrillation and a rapid ventricular response. An apical right ventricular lead position also appears critical for optimal reduction of the LV outflow pressure gradient.

More recent studies have yielded more variable results in patients treated with DDD pacing for HOCM. In a recent multicenter, randomized, double-blind, crossover study of permanent DDD pacing in 48 patients with drug-refractory HOCM, Maron et al found an average reduction of outflow gradient of 40% but no change in exercise capacity, peak oxygen consumption, or LV wall thickness in the overall group. However, an improved functional capacity occurred in a small subset of 12% who were older than 65 years of age. Thus, DDD pacing is not primary or routine adjunctive therapy for HOCM but should be used as alternative therapy for selected patients in whom medical therapy is ineffective and in whom myotomy-myectomy is not feasible. Another possible approach in such patients is alcohol septal ablation.

**Pacing for Dilated Cardiomyopathy**

There has been less experience with dual-chamber pacing for patients with severe LV systolic dysfunction (dilated cardiomyopathy). Also, there has been considerable doubt concerning the usefulness of implanting permanent pacemakers for the treatment of severe LV systolic dysfunction.

Treatment of patients with dilated cardiomyopathy by short-AV-interval (100 ms) pacing was first reported by Hochleitner et al in 1990. All 16 patients were severely symptomatic despite therapy with diuretics, digitalis, and vasodilators. Patients were monitored clinically for 1 year after implantation of DDD pacemakers with electrodes positioned in the right atrial appendage and right ventricular apex. Symptoms of severe dyspnea and pulmonary edema were reported to have “almost disappeared” shortly after implantation, with New York Heart Association functional class improving from an average of 3.6 to 2.1. Mortality at 1 year (25%) was “considerably less” than generally expected for a population with such advanced disease.

In 1993, Auricchio et al implanted permanent dual-chamber pacemakers programmed to provide P-synchronous (VDD) pacing with an AV delay of 100 ms in 2 patients with coronary artery disease and severe heart failure. The AV interval was chosen from Doppler studies indicating the longest diastolic filling period on mitral flow-velocity curves and maximum aortic outflow velocities. In both patients, ascites and leg edema disappeared and diuretic requirements declined.

Subsequent reports failed to confirm these initial observations. Studies by Linde et al and by Gold and associates concluded that the use of pacemaker therapy as primary therapy for congestive heart failure was unjustified.

Several subsequent studies defined certain subgroups of patients with severe LV dysfunction in whom the timing of AV mechanical activation was clearly disturbed. Patients who may have a favorable hemodynamic response to dual-chamber pacing include (1) those with an atrial contraction too early in relation to the onset of ventricular contraction during native conduction, (2) patients with long AV conduction and significant shortening of the diastolic filling period because of presystolic mitral or tricuspid regurgitation or both, and (3) certain patients with PR intervals >200 ms in whom dual-chamber pacing at an optimal AV delay eliminates diastolic mitral regurgitation and improves cardiac output.

In an important study by Kass et al, VDD pacing acutely enhanced contractile function in 18 dilated cardiomyopathy patients with intraventricular conduction delay. Data during sinus rhythm were compared with ventricular pacing (VDD) at various sites and AV delays (randomized order). LV free-wall pacing elevated dP/dt max by >23% and pulse pressure by >18%. Optimal AV intervals averaged 125 ms, and within this range, AV delay had less influence on ventricular function than the pacing site. The authors concluded that single-site pacing at the site of greatest delay resulted in similar or greater benefits than biventricular pacing in such patients when studied over the short term.

**Conclusions**

Pacing should never be considered primary therapy in patients with cardiomyopathies. Unfortunately, hemodynamic improvements do not always translate into survival benefit, and very careful patient selection is mandatory. The determination of an appropriate AV interval (usually short) is crucial to the success of dual-chamber pacing in the myopathic heart.

For patients with HOCM, dual pacing continues to develop as a possible alternative option when medical and surgical therapy are unsuccessful or unfeasible. Patients with outflow obstruction in whom adequate apical septal preexcitation is attainable without diminution of atrial contribution to ventricular filling will likely derive the greatest benefit.
The usefulness of pacing for patients with severe dilated cardiomyopathy is less likely. However, it is reasonable to consider pacing when timing of AV mechanical activation is clearly disturbed.3 Demonstration of diastolic AV valve regurgitation by continuous-wave Doppler is a useful indicator of AV dyssynchronization.

Information concerning the impact of pacemaker therapy on cardiomyopathic states will improve with the acquisition of greater patient experience and longer follow-up. Clinical, echocardiographic, and hemodynamic markers must be optimized to select patients likely to derive the greatest benefit from pacing. Controlled, randomized studies of sufficient size and duration are necessary before pacing can be recommended on a more widespread basis. The report by Kass and associates12 suggests that VDD pacing may provide alternative therapy for selected patients with HHCO, but greater experience with many more patients with this cardiac disorder is a necessary prerequisite for its clinical use in this setting.

References


Key Words: Editorials ■ pacing ■ cardiomyopathy
Cardiac Pacing: An Alternative Treatment for Selected Patients With Hypertrophic Cardiomyopathy and Adjunctive Therapy for Certain Patients With Dilated Cardiomyopathy

Robert A. O'Rourke

Circulation. 1999;100:786-788
doi: 10.1161/01.CIR.100.8.786

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/100/8/786

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org/subscriptions/