ISSN 0735-1097/04/$30.00
doi:10.1016/j.jacc.2003.10.028

EDITORIAL COMMENT

Pacing the Left Ventricle: Does Underlying Rhythm Matter?*

Angelo Auricchio, MD, PhD
Magdeburg, Germany

Cardiac resynchronization therapy (CRT), a left-sided ventricular pacing therapy for highly symptomatic heart failure (HF) patients with ventricular conduction delay, is indicated in patients with preserved sinus rhythm (SR) (1). Few data are available on whether CRT might benefit patients with chronic atrial fibrillation (AF) after atrioventricular (AV) junction ablation. The study by Puggioni et al. (2) in this issue of the *Journal* helps to define the potential role of CRT in a pacemaker-dependent AF patient population.

See page 234

Cardiac resynchronization therapy can be delivered either by simultaneous pacing of the right ventricle (RV) and left ventricle (LV; commonly referred to as biventricular pacing) or by pacing the LV alone after sensing or pacing the atrium at a given AV delay. Both methods can re-time the delayed ventricle by resynchronizing LV and RV contractions, resynchronizing regional LV wall motion, and maximizing preload by shortening the AV delay (3–5). In patients with SR, biventricular pacing and LV pacing alone improve short-term systolic pump function to a similar extent (3–6) and, after short-term treatment, similarly improve the symptoms, quality of life, and exercise capacity of patients with severe HF (7).

Atrial fibrillation, a frequent comorbidity in symptomatic HF patients, can be a challenging arrhythmic disorder to treat. The long-term management of AF is often unsatisfactory despite the availability of numerous pharmacologic and non-pharmacologic therapies. The ability of ablation and pacing therapy to provide relief to the most highly symptomatic patients meets a large and growing challenge in clinical practice. However, recent reports have pointed out that long-term RV pacing may be responsible for the onset or aggravation of symptoms of HF after ablation of the AV junction (8,9). Indeed, RV pacing induces asynchronous activation of the LV, which may mimic the abnormal activation sequence of left bundle branch block that is present in most patients currently receiving CRT (10).

Recognizing this problem, a few studies have tried to extend CRT to HF patients with AF and AV junction ablation. The results are mixed. Such patients upgraded from RV to biventricular pacing exhibited positive clinical improvement (11). However, the prospective, randomized Multisite Stimulation in Cardiomyopathies study, which compared biventricular and RV pacing in this population, failed to meet its end points with an intention-to-treat analysis (12).

The study by Puggioni et al. (2) tested the unique hypothesis that LV pacing alone may be an effective alternative to chronic RV pacing in pacemaker-dependent AF patients. They included patients with and without previous ventricular conduction delay, some presenting with HF, but many not. All patients had ablation of the AV junction because of high ventricular rates due to AF. The study compared the changes in acute ventricular pump function with LV pacing alone to conventional RV pacing. The main result was that LV pacing provided a statistically significant but minor clinical advantage over RV pacing. Furthermore, rhythm regularization by ablation provided the main therapeutic benefit, whereas the pacing site played a minor role by incrementally improving LV systolic function. It is unfortunate that their study did not also compare the effects of biventricular pacing because a larger advantage in that mode is possible in pacemaker-dependent patients.

This can be deduced from the Puggioni et al. (2) results, first by observing that LV pacing alone would appear to be much less effective in patients with AF than in patients with SR, regardless of whether a previous ventricular delay is present. In patients with ventricular conduction delay and SR, LV pacing alone usually increases LV systolic function by around 20% and usually improves systolic function twofold to threefold more than RV pacing (4). In the AF patients of the Puggioni et al. study (2), LV pacing increased ejection fraction only 5.7% more than with RV pacing. This difference may be explained by the several ways that underlying rhythm can modulate the effect of ventricular pacing on pump function, including altering preload and creating an intrinsic activation front conducted through the AV node. Recent data suggest that the optimal resynchronization for increasing LV contractile function with LV pacing occurs with a fusion of intrinsic RV activation and paced LV activation (13,14). Clearly, after ablating the AV node, intrinsic rhythm is not conducted; thus, fusion is not possible. In this situation, pre-excitation of only the LV may create a delayed activation of the septum and RV, which worsens ventricular pump function, analogous to deficits generated by RV-only pacing. Therefore, biventricular pacing may be more effective than LV pacing alone in these patients.

Although the long-term results of the Optimal Pacing Site (OPSITE) study are eagerly awaited, the question of whether LV pacing should be considered as a first-line treatment in patients with AF undergoing ablation of the AV junction remains unanswered. The short-term data by Puggioni et al. (2), which showed only minor improvements with LV pacing versus RV pacing, seem insufficient to

*Editorials published in the *Journal of the American College of Cardiology* reflect the views of the authors and do not necessarily represent the views of *JACC* or the American College of Cardiology.

From the Division of Cardiology, University Hospital, Magdeburg, Germany.

JACC Vol. 43, No. 2, 2004
January 21, 2004:239–40

justify the additional patient risk and difficulty of implanting an LV-only pacing system. Furthermore, for these patients, there can be a safety issue with the relatively young technique of LV-only pacing. After patients have been made pacemaker-dependent by ablating the AV junction, the implanted pacing system must be highly reliable and stable. Although stability and electrical characteristics of the latest generation of long-term LV pacing leads are markedly improved, they still are reported to have higher dislocation rates and higher stimulation thresholds than conventional RV pacing leads. Thus, safety may be the most important issue to consider at this time when contemplating the use of LV pacing alone to deliver CRT in post-ablation patients.

Reprint requests and correspondence: Dr. Angelo Auricchio, Division of Cardiology, University Hospital, Leipziger Strasse 44, 39120 Magdeburg, Germany. E-mail: angelo.auricchio@medizin.uni-magdeburg.de.

REFERENCES

1. Gregoratos G, Abrams J, Epstein AE, et al. ACC/AHA/NASPE 2002 guideline update for implantation of cardiac pacemakers and antiarrhythmia devices—summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/NASPE Committee to update the 1998 pacemaker guidelines). J Am Coll Cardiol 2002;40:1703–19.
2. Puggioni E, Brignole M, Gammage M, et al. Acute comparative effect of right and left ventricular pacing in patients with permanent atrial fibrillation. J Am Coll Cardiol 2004;43:234–8.
3. Kass DA, Chen CH, Curry C, et al. Improved left ventricular mechanics from acute VDD pacing in patients with dilated cardiomyopathy and ventricular conduction delay. Circulation 1999;99:1567–73.
4. Auricchio A, Stellbrink C, Block M, et al. The effect of pacing chamber and atrioventricular delay on acute systolic function of paced patients with congestive heart failure. Circulation 1999;99:2993–3001.
5. Auricchio A, Ding J, Spinelli JC, et al. Cardiac resynchronization therapy restores optimal atrioventricular mechanical timing in heart failure patients with ventricular conduction delay. J Am Coll Cardiol 2002;39:1163–9.
6. Auricchio A, Stellbrink C, Sack S, et al. Long-term clinical effect of hemodynamically optimized cardiac resynchronization therapy in patients with heart failure and ventricular conduction delay. J Am Coll Cardiol 2002;39:2026–33.
7. Auricchio A, Stellbrink C, Butter C, et al. Clinical efficacy of cardiac resynchronization therapy using left ventricular pacing in heart failure patients stratified by severity of ventricular conduction delay. J Am Coll Cardiol 2003;42:2109–16.
8. Ozcan C, Jahangir A, Friedman PA, et al. Long-term survival after ablation of the atrioventricular node and implantation of permanent pacemaker in patients with atrial fibrillation. N Engl J Med 2001;344:1043–51.
9. Wood M, Brown-Mahoney C, Kay GN, et al. Clinical outcomes after ablation and pacing therapy of atrioventricular junction. Circulation 2000;101:1138–44.
10. Prinzen FW, Hunter WC, Wyman BT, et al. Mapping of regional myocardial strain and work during ventricular pacing: experimental study using magnetic resonance imaging tagging. J Am Coll Cardiol 1999;33:1735–42.
11. Leon AR, Greenberg JM, Kanuru N, et al. Cardiac resynchronization in patients with congestive heart failure and chronic atrial fibrillation: effect of upgrading to biventricular pacing after chronic right ventricular pacing. J Am Coll Cardiol 2002;39:1258–63.
12. Leclercq C, Walter S, Linde C, et al. Comparative effects of permanent biventricular and right-univentricular pacing in heart failure patients with chronic atrial fibrillation. Eur Heart J 2002;23:1780–8.
13. Yu Y, Kramer A, Spinelli J, et al. Biventricular mechanical asynchrony predicts hemodynamic effect of uni- and biventricular pacing. Am J Physiol Heart Circ Physiol 2003;285:H2788–96.
14. Verbeek XA, Vernooy K, Peschar M, Cornelussen RN, Prinzen FW. Intraventricular resynchronization for optimal left ventricular function during pacing in experimental left bundle branch block. J Am Coll Cardiol 2003;42:558–67.