

Congestive Heart Failure: Therapeutic Alternative with Artificial Cardiac Stimulation

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Summary

The Brazilian Health Ministry reports that there are about 2,000,000 patients with heart failure in Brazil, with a prevalence of 240,000 cases in the State of Paraná alone. The morbidity and mortality among these patients has improved considerably with the advent of pharmacological treatment. Transplantation has been the technique with best results, but there are limitations with respect to donors and the postoperative segment. Artificial cardiac stimulation in the treatment of heart failure patients with dilated cardiomyopathy and non-conventional indications appears to be an important way to deal with this disease while waiting for transplantation.

Key Words

Congestive heart failure, artificial stimulation, biventricular pacing

Introduction

According to the Health Ministry, there are about 2,000,000 patients with heart failure in Brazil, with a prevalence of 240,000 cases in the State of Paraná [1]. Approximately 30 % of those patients are hospitalized annually, and mortality is about 10 % per year for non-selected cases, and varies from 30 % to 40 % a year for patients in NYHA classes III and IV [2]. Despite the pharmacological therapeutic evolution, especially the use of ACE inhibitors which considerably improved the morbidity and mortality among heart failure patients, the total mortality is still high [3]. There are several options for non-pharmacological treatment, such as mechanical circulatory support (intra-aortic balloon, continued flux pump, artificial ventricle and heart), surgical treatment (cardiac transplantation, dynamic cardiomyoplasty, Batista technique, valvoplasty or valve replacement, left ventricle geometric repair) and electrical treatment (pacemaker and implantable cardioverter defibrillator). Transplantation has been the technique with best results; however, there are limitations with respect to donors and the postoperative segment [4]. Hochleitner introduced artificial cardiac stimulation in the treatment of heart fail-

ure patients, with dilated cardiomyopathy and non-conventional indications in 1990 [5]. The purpose of the present work is to present the experience acquired by the "Serviço de Cirurgia Cardíaca do Hospital Universitário Cajuru da Pontifícia Universidade Católica do Paraná" in using this therapy for treating cardiac insufficiency in patients in NYHA functional class III and IV.

Dual-chamber Artificial Cardiac Pacing with Short AV Interval

Literature Review

In 1990, Hochleitner reported on a series of 16 patients with dilated idiopathic cardiomyopathy who suffered from congestive cardiac insufficiency of functional class III and IV, which was refractory to pharmacotherapy; seven of these patients were referred for heart transplantation. None of the patients had indications for pacemaker implantation, with PR intervals between 140 and 320 ms (198 ± 43 ms). Seven presented with left bundle branch block (LBBB). A DDD pacemaker with a programmed AV interval of 100 ms

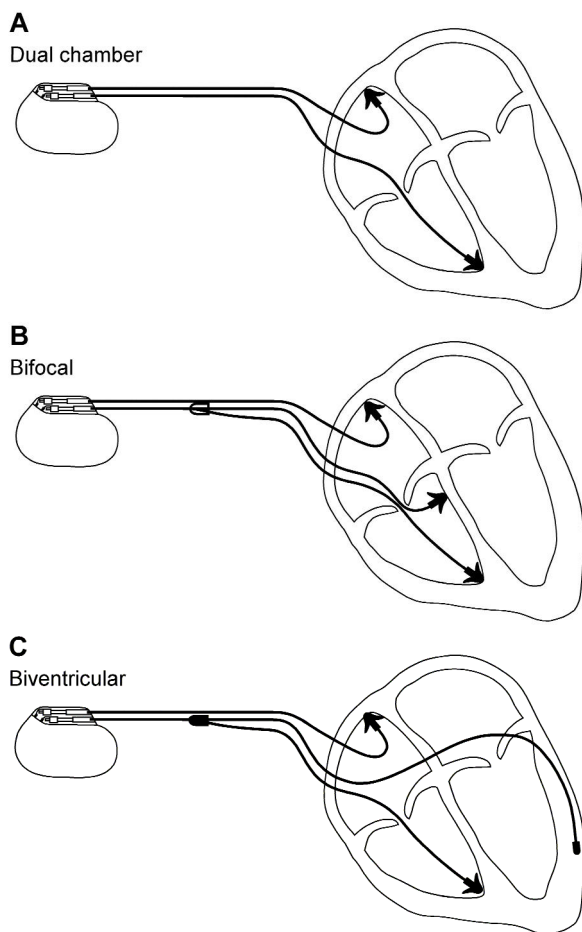


Figure 1. Schematic figure of dual chamber artificial cardiac pacing (panel A), bifocal stimulation (panel B), and biventricular stimulation (panel C) using a DDD pacemaker system.

was implanted (Figure 1a). Over a period that varied from 2 to 14 days a change occurred and the NYHA functional class decreased from 3.6 ± 0.4 to 2.1 ± 0.5 , and the ejection fraction improved from $16 \pm 8\%$, to $26 \pm 9\%$ [5]. Two years later, the author published another article describing the long-term results, demonstrating that out of 17 patients treated with that technique, ten died in a 2 - 32 month period, four underwent transplantation, and only three survived. This author did not describe either the mechanism or the reason for choosing the technique [6]. In 1992, Brecker studied 12 patients under the same clinical conditions as those patients, modifying the AV interval for either temporary or permanent DDD stimulation,

and demonstrated the relation between the AV interval on the one hand, and the mitral reflux time (MRT) and the left ventricular filling time (LVFT) on the other hand. A shorter AV interval reduced the MRT and increased the LVFT. These effects improved the cardiac output, the exercise capacity time, and the oxygen consumption. This explains the mechanism of hemodynamic and functional improvement in patients [7].

Results from our Study Group

Between January 1996 and March 1996, artificial cardiac pacemakers were implanted in eight patients with 1st degree heart block and LBBB, to treat heart failure. Their age ranged from 23 to 78 (mean 61.7 years), with five men and three women. They all had dilated cardiomyopathy; five had NYHA functional class IV and three had functional class III. In the electrocardiogram, the average PR interval was 23 ms and the average QRS width was 14 ms. The MRT and the LVFT related to the RR duration were evaluated in the preoperative period. The first took 66.3 %, and the second 33.6 % of the RR time. The implant applied a 100 ms AV interval to all patients; six patients were paced in DDD mode and two in VDD. After implant, five patients improved to functional class II, and three to functional class III, within an average time period of 9.6 months. In the postoperative Doppler echocardiographic evaluation, it was verified that the MTR decreased to 51.5 % and the LVFT increased to 48.3 % of the RR time, improving the left ventricular ejection period in 53.1 % and the cardiac output in 40.4 %, compared to the preoperative data. Postoperatively, four out of the eight patients died within 6 and 15 months, one had heart transplantation, two had NYHA functional class II and one had functional class III.

Bifocal Stimulation

Literature Review

In 1999, Pachon Mateos et al. reported the utilization of right ventricular bifocal stimulation in the treatment of dilated cardiomyopathy with heart failure in five patients (52.2 ± 17.7 years). They used two leads in the right ventricle, one in the apex and the other at the intraventricular septum, connected to ventricular and atrial pacemaker ports, respectively. Using Doppler echocardiography, he compared the results of conventional (VVI pacemaker mode), high septal (AAI mode), and bifocal (DDT mode with AV interval = 0) pacing. The right ventricle bifocal stimulation

(Figure 1b) had the best results with an increase in ejection fraction and cardiac output, a reduction in QRS duration and mitral regurgitation. The patients had chronic atrial fibrillation with high degree or complete AV block with conventional indication for pacemaker [8]. In 2000, the same group reported a reduction of mitral regurgitation due to endocardial right ventricular bifocal pacing in cases of dilated cardiomyopathy [9]. In 21 patients (62.8 ± 12.4 years), bifocal pacing has been shown to significantly reduce mitral regurgitation and duration of the QRS complex with respect to conventional apical ventricular unifocal pacing and ventricular septal unifocal pacing.

Results from our Study Group

Between March 1999 and April 2000, this technique was used in three patients with ages ranging between 40 and 59 years. They suffered from dilated cardiomyopathy, with refractory congestive heart failure; one patient was in functional class III and two were in functional class IV. They all had been in the hospital more than three times for the last 4 months prior to the implant. The echocardiography of two of them showed first-degree His block and LBBB; the other showed atrial fibrillation with advanced complete heart block. After implantation, all patients experienced a reduction in the QRS duration from 160 to 130 ms (mean), with a functional class improvement in two patients. The cardiac output increased by 30.2 %, and ejection fraction by 18.6 %, compared to preoperative period of all three patients. After 2 months, the patient with VDD stimulation returned to functional class IV and underwent a heart transplant. The other two presented in functional class II with a mean evolution time of 6.4 months.

Biventricular Stimulation

Literature Review

In 1994, Becker was the first to describe the potential value of permanent biventricular cardiac stimulation. He implanted DDD pacemakers in five patients with decreased ventricular function and LBBB, using two ventricular leads, one endocavitarily positioned in the right ventricle and another epimyocardially positioned in the left ventricle (Figure 1c). After the implant, the AV interval was optimized for each patient. After 3 months, four patients improved to functional class I. The only patient who did not improve lost left ventricle lead control at the 3rd month of follow-up. On average, four patients increased the ejection fraction by

8 ± 2 % and the systolic volume by 12 ± 3 ml, while the left ventricle diastolic filling time was 90 ± 56 ms. In addition, the mitral regurgitation decreased significantly. Several authors, including Cazeau 1996, Daubert 1997, Auricchio 1999, described promising results with this technique [10-12].

The coronary sinus lead technique (Daubert) is still associated with high threshold, dislocation and positioning difficulties, motivating cardiovascular companies to work on the improvement of coronary sinus leads [13].

Results from our Study Group

Our experience began in March 2000, and corresponds to four patients with ages ranging from 46 to 63 years. They had dilated cardiomyopathy, NYHA functional class IV, and had been in hospital several times during the last 6 months. The percent shortening, i.e. diastolic to systolic difference in left ventricular diameter with respect to diastolic diameter varied between 10 % and 16 %; three patients had a first-degree His block and LBBB, and were stimulated in DDD mode. The leads were positioned in the right atria, right ventricle, and left marginal vein. One patient with atrial fibrillation and complete heart block was paced in DDDR mode, with one lead positioned in the right ventricle and connected to the atrial channel. The AV interval was programmed to 15 ms. Two patients showed dislodgement of the lead positioned in the left ventricle during the immediate postoperative period and it was necessary to replace it. Mean postoperative values improved with respect to the preoperative values: percent shortening increased by 30.4 %, and cardiac output increased by 20.7 %. The QRS duration was reduced from 170 to 130 ms. Three patients are in class II and one is in class III; none was hospitalized.

Discussion

Despite a small number of cases, several conclusions can be drawn from our experience:

- The dual-chamber pacing with short AV intervals improved the functional class and hemodynamics right after implantation, but it was associated with high morbidity and mortality during follow-up.
- Bifocal pacing is an interesting alternative, mainly for its narrowing of QRS duration, and this technique could be reserved for selected cases.
- In spite of the dislodgement and positioning difficulties of coronary sinus lead, biventricular pacing had

the best results in improving hemodynamic parameters and functional class in using electrical therapy to treat congestive heart failure in patients with LBBB and dilated cardiomyopathy.

References

- [1] Datasus, Ministério da Saúde, Brasil. Óbitos de residentes - Brasil. Período de 1995. Sistema de Informações sobre Mortalidade (SIM) 1998.
- [2] II Diretrizes da Sociedade Brasileira de Cardiol. para Diagnóstico e Tratamento da Insuficiência Cardíaca. Arquivos Brasileiros de Cardiologia 1998; 72 (Supl. 72;4-30).
- [3] Salgado FoW. Papel dos antagonistas dos receptores da angiotensina II na Insuficiência Cardíaca Congestiva. Revista Soc. Cardiol. Estado de São Paulo 2000, 1: 88-100.
- [4] Stolf N, Fiorelli A. Transplante Cardíaco. In: Sousa A, Mansur A (eds). SCOCESP Cardiologia, 2a Ed. São Paulo; Atheneu. 1996: 743-755.
- [5] Hochleitner M, Hortnagl H, Ng CK, et al. Usefulness of physiologic dual chamber pacing in drug-resistant idiopathic dilated cardiomyopathy. Am J Cardiol. 1990; 66: 198-202.
- [6] Hochleitner M, Hortnagl H, Friedrich L, et al. Long-term efficacy of physiologic dual chamber pacing in the treatment of end-stage idiopathic dilated cardiomyopathy. Am J Cardiol. 1992; 70: 1320-1325.
- [7] Brecker S, Xiao H, Sparrow J, et al. Effects of dual chamber pacing with short atrioventricular delay in dilated cardiomyopathy. Lancet. 1992; 340: 1308-1311.
- [8] Pachón MJC, Albornóz R, Pachón ME, et al. Right ventricular bifocal stimulation in treatment of the dilated cardiomyopathy with heart failure. Prog Biomed Res. 1999; 4: 254-262.
- [9] Pachón MJC, Albornóz R, Pachón MEI, et al. Reduction of mitral regurgitation by endocardial right ventricular bifocal pacing in case of dilated cardiomyopathy. Prog Biomed Res. 2000; 5:233-238.
- [10] Bakker P, Meijburg H, de Jonge N, et al. Beneficial effects of biventricular pacing in congestive heart failure. PACE. 1994; 17: 820. (abstract).
- [11] Cazeau S, Ritter P, Lazzarus A, et al. Hemodynamic improvement provided by biventricular pacing in congestive heart failure an acute study. PACE. 1996; 19: 568. (abstract).
- [12] Aurichio A, Stelbrink C, Sack S, et al. The Pacing Therapies of Congestive Heart Failure (PATH-CHF) study: rationale, design and endpoints of a prospective randomized multicenter study. Am J Cardiol. 1999; 83: 130D-135D.
- [13] Daubert C, Leclercq C, Le Breton H, et al. Permanent left atrial pacing with a specifically designed coronary sinus lead. PACE. 1997; 11: 2755-2764.

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