

Cardiac Resynchronization Therapy in Congestive Heart Failure also Provides Beneficial Effects for Rhythm Control of Atrial Fibrillation

Chung-Ho Hsu, Kuan-Cheng Chang, Pei-Ying Pai, Ping-Han Lo, Yu-Chin Lin

Division of Cardiology, Department of Medicine, China Medical University Hospital, Taichung, Taiwan.

Two patients with dilated cardiomyopathy and persistent atrial fibrillation (AF) underwent successful electrical cardioversion and atrioventricular (AV) junction ablation, followed by implantation of a cardiac resynchronization therapy (CRT) pacemaker with a biventricular pacing system. The duration of persistent AF was one week in patient one and one year in patient two. The interventions resulted in marked improvement in refractory heart failure as well as rhythm control of AF. Patient one was free of AF at 11-month follow-up, and patient two had had markedly fewer episodes of paroxysmal AF during a follow-up period of 6 months. The anecdotal evidence in our two patients suggests that reduction of atrial size and atrial stretch after CRT and hence the atrial anatomical-electrical remodeling is the underlying mechanism for the improvement of rhythm control of AF. (*Mid Taiwan J Med* 2006;11:50-5)

Key words

atrial fibrillation, biventricular pacing, cardiac resynchronization therapy, congestive heart failure

INTRODUCTION

Cardiac resynchronization therapy (CRT) with atrial-synchronized biventricular pacing is an effective treatment modality in patients with refractory congestive heart failure (CHF) and intraventricular conduction delay. Previous studies have shown that CRT improves symptoms, exercise tolerance, and quality of life by synchronizing heart contraction and decreasing mitral regurgitation [1-8]. About 25% of patients with CHF (New York Heart Association (NYHA) functional class III) develop atrial fibrillation (AF) during the course of their illness [9]. The beneficial effects of CRT on rhythm control of AF have not been well documented. In this report, we

present two patients with advanced CHF and persistent AF, who underwent electrical cardioversion and atrioventricular junction (AV) ablation followed by implantation of a CRT pacemaker. The treatment resulted in improvement of CHF as well as rhythm control of AF.

CASE REPORT

Patient 1

A 91-year-old man with dilated cardiomyopathy and persistent AF was admitted in December 2002 for CRT pacemaker implantation because he had CHF (NYHA functional class III-IV) and was refractory to carvedilol, digoxin, captopril, furosemide, and spironolactone. Paroxysmal AF was first noted in November 2000 and became persistent in November 2002 despite treatment with amiodarone. His CHF further deteriorated with

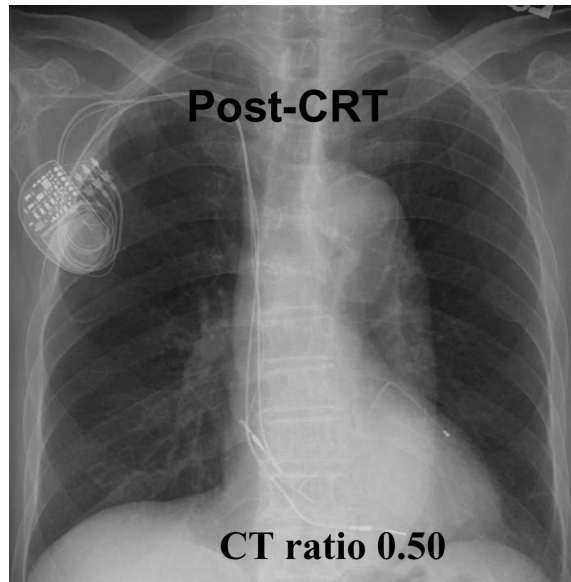
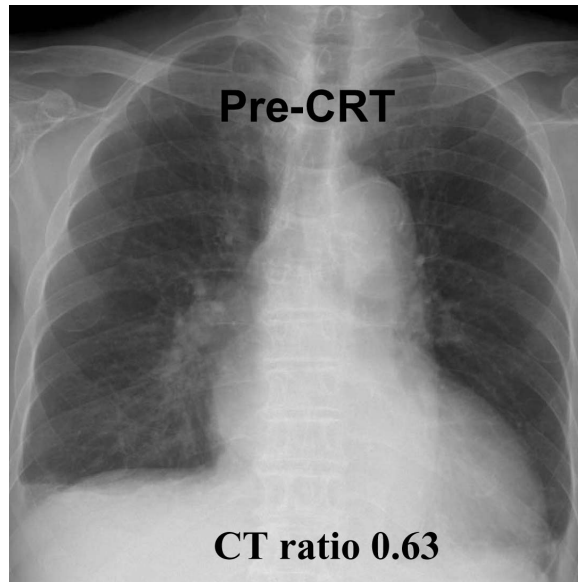
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Address reprint requests to : Kuan-Cheng Chang, Division of Cardiology, Department of Medicine, China Medical University Hospital, 2 Yuh-Der Road, Taichung 404, Taiwan.

Patient 1



Patient 2

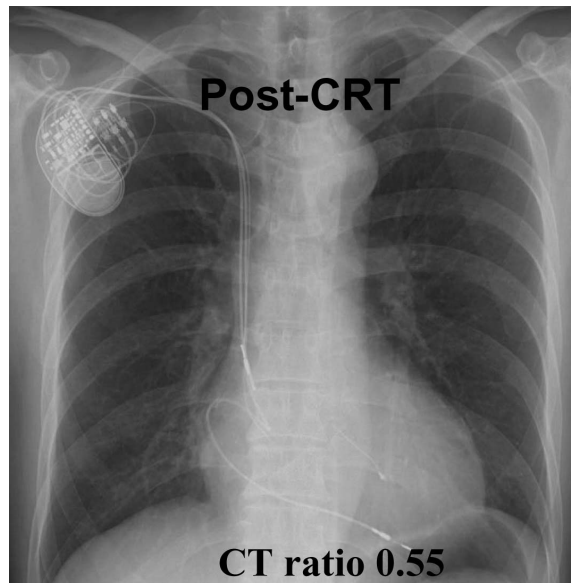
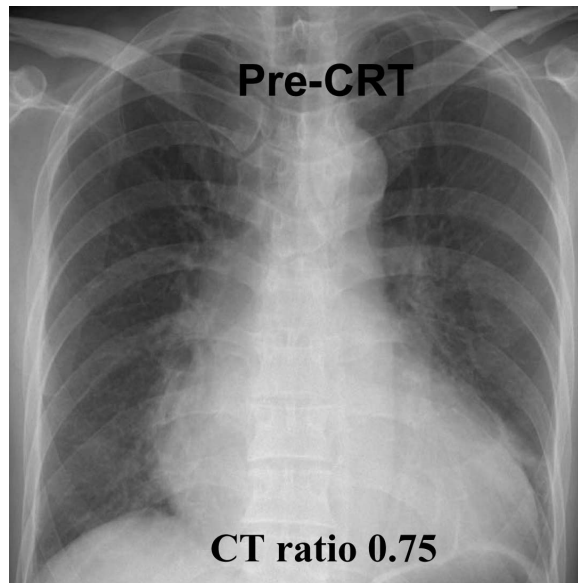


Fig. 1. Chest roentgenograms showing reduction in heart sizes after cardiac resynchronization therapy (CRT). CT = cardiothoracic.

the onset of AF. The baseline ECG showed left bundle branch block with a QRS duration of 174 ms.

After excluding left atrial thrombus by transesophageal echocardiography, sinus rhythm was restored after successful electrical cardioversion of AF. A temporary pacemaker was implanted by successful AV junction ablation. The next day, a CRT pacemaker (Medtronic, In-Sync III, model 8042) was implanted. The left

ventricle was paced 20 ms earlier than the right ventricle, which produced the narrowest paced QRS complexes. The AV delay was adjusted according to Ritter's formula [10].

At 11-month follow-up, the NYHA functional class had improved from class IV to class II. Chest roentgenograms and echocardiography showed marked reduction in cardiac size (Fig. 1, upper panel; Table). Echocardiograms also showed improvement in

Table. Functional class, QRS duration, echocardiographic and hemodynamic parameters at baseline and after intervention

Parameters	Patient 1		Patient 2	
	Baseline	Follow-up (11 mo)	Baseline	Follow-up (6 mo)
NYHA Fc	4	2	4	2
QRS (ms)	174	120	172	140
LVEDD (mm)	72	49	70	62
LVESD (mm)	65	28	59	49
LVEF (%)	29	64	28	45
LAD (mm)	48	42	43	31
MR severity	Mod	Mild	Mod	Mild
Mean RAP (mmHg)	11	8	9	3
PAP (mmHg)	48/23 (35)	21/5 (13)	38/20 (29)	23/14 (15)
PAWP (mmHg)	32	8	20	7
CO/CI (L/min)	2.3/1.4	3.2/2.1	4.0/2.3	6.2/3.4

Fc = functional class; LVEDD = left ventricular end-diastolic dimension; LVESD = left ventricular end-systolic dimension; LVEF = left ventricular ejection fraction; LAD = left atrial dimension; MR = mitral regurgitation; RAP = right atrium pressure; PAP = pulmonary artery pressure; PAWP = pulmonary artery wedge pressure; CO = cardiac output; CI = cardiac index; Mod = moderate.

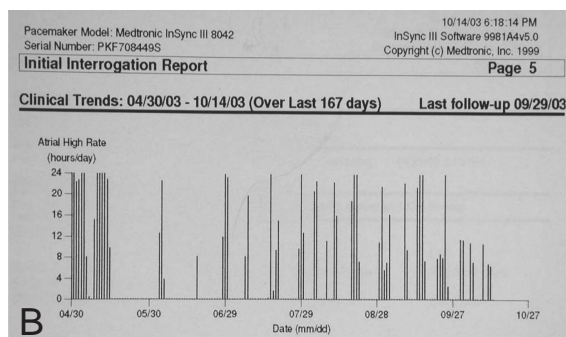
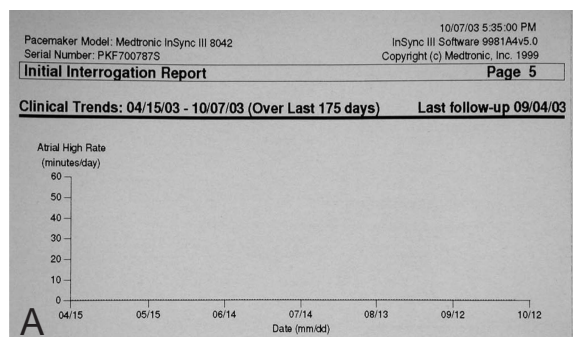


Fig. 2. Stored algorithm recordings from the pacemaker show freedom of atrial fibrillation in patient 1 (panel A) and a decrease in atrial fibrillation frequency and duration in patient 2 (panel B).

left ventricular ejection fraction from 29% to 64% and decrease in the degree of mitral regurgitation. Hemodynamic study displayed normalization of pulmonary artery wedge pressure, pulmonary artery pressure and right atrium pressure (Table). The patient has been maintained in sinus rhythm and free of AF episodes since the operation, as documented by the stored data from the pacemaker (Fig. 2A), while on the same dose of amiodarone, which was previously ineffective for AF control.

Patient 2

A 57-year-old man with dilated cardiomyopathy and persistent AF was admitted in April 2003 for CRT because of advanced CHF refractory to treatment with carvedilol, digoxin, captopril, losartan and furosemide. Paroxysmal

AF was detected in October 2001. Sinus rhythm had been maintained with amiodarone until AF became persistent in March 2002. The patient presented with AF, rapid ventricular rate and deteriorating CHF. The baseline ECG displayed left bundle branch block with a QRS duration of 172 ms.

After excluding left atrial thrombus by transesophageal echocardiography, sinus rhythm was restored after successful electrical cardioversion of AF. A temporary pacemaker was inserted followed by successful AV junction ablation. The next day, a CRT pacemaker (Medtronic, In-Sync III, model 8042) was implanted. The left ventricle was paced 20 ms earlier than the right ventricle, which produced the narrowest QRS duration. The AV delay was

adjusted according to Ritter's formula.

Six months after the procedure, the NYHA functional class had improved from class IV to II. Chest roentgenograms showed reduction of cardiothoracic ratio (Fig. 1, lower panel). Echocardiograms revealed an increase in left ventricular ejection fraction from 28% to 45%, a reduction in the severity of mitral regurgitation and a decrease in left atrial and left ventricular dimensions (Table). Hemodynamic study displayed normalization of pulmonary artery wedge pressure, pulmonary artery pressure and right atrium pressure (Table). Stored data from the pacemaker showed marked reduction of paroxysmal AF episodes (Fig. 2B).

DISCUSSION

CRT with atrial-synchronized biventricular pacing in patients with refractory heart failure and left bundle branch block improves symptoms, quality of life, exercise capacity and left ventricular function [1-8]. AF is a common arrhythmia associated with moderate-to-severe CHF [9]. Previous studies have demonstrated that the effects of CRT on CHF are comparable between patients with stable sinus rhythm and those with chronic AF [11]; however, whether CRT provides additional beneficial effects for rhythm control of AF in patients with CHF is not well documented in the literature.

Malinowski [12] described a spontaneous recovery of permanent AF to sinus rhythm 17 months after biventricular pacing in a 68-year-old man with refractory CHF without AV nodal ablation and cardioversion. The outcome in our two patients also provides anecdotal evidence which suggests that CRT, in addition to improving refractory heart failure, may improve rhythm control of AF.

Animal models have demonstrated that chronic atrial enlargement may increase vulnerability to atrial arrhythmias caused by atrial electrical remodeling in response to chronic atrial stretch [13-15]. Thus, we speculate that CRT in CHF improves rhythm control of AF by reversing atrial enlargement and diminishing the atrial pressure. In our patients, electrical cardioversion

was performed to restore sinus rhythm prior to biventricular pacing, and amiodarone was maintained after the interventions. This therapeutic approach resulted in complete elimination of AF in one patient and diminished frequency of paroxysmal AF in the other during a follow-up period of 11 months and 6 months respectively. In both patients, echocardiographic studies demonstrated reduction in the left atrial and left ventricular dimensions and mitral regurgitation severity, as well as improvement in the left ventricular ejection fraction. Hemodynamic studies displayed normalization of the pulmonary artery wedge, pulmonary artery and right atrial pressures as well as improvement in cardiac output. The beneficial effect of rhythm control of AF correlated with the favorable changes in echocardiographic and hemodynamic parameters during follow-up. The reduction of left ventricular dimension and improvement in the left ventricular ejection fraction, decreased left atrial dimension and stretch, hence improved rhythm control of AF.

Melenovsky [16] et al concluded that in heart failure patients with AF, RR-interval irregularity worsens cardiac function at elevated but not at normal range heart rate. Overall rate control is most important in these patients while rate regularization of rapid AF may impart additional benefits. Ozcan et al [17] demonstrated that in patients with drug-refractory AF and left ventricular dysfunction, control of ventricular rate by AV junction ablation and implantation of a conventional single or dual-chamber pacemaker is associated with improved left ventricular function. They found near normalization of left ventricular ejection fraction in 29% of study patients, in whom the observed survival was comparable to that of the normal subjects. In a similar study [18], the improvement in left ventricular systolic function had been found to be due to reduction of the end-systolic left ventricular diameter with no appreciable change in the end-diastolic diameter. Therefore, based on the above evidence, we believed that adequate control of ventricular rate after AV junction ablation might have exerted a synergistic effect

on the left ventricular systolic function in our patients. Nonetheless, CRT was responsible for the improvement of left ventricular function as significant reduction of the end-diastolic along with the end-systolic left ventricular dimension was observed in our patients.

In summary, our report demonstrates that CRT in CHF patients can facilitate rhythm control of AF, possibly by reversing chronic atrial stretch and diminishing atrial pressure by reversing the atrial anatomical-electrical remodeling process.

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心臟再同步化治療應用於鬱血性心衰竭可改善心房顫動的控制

徐中和 張坤正 白培英 羅秉漢 林於錦

中國醫藥大學附設醫院 心臟內科

有兩位患有擴張性心肌病變合併持續性心房顫動的病患在經過電擊整流術，房室結電燒術，及放置心臟再同步化心律調節器後，得到有效的治療。兩位病患罹患持續性心房顫動的時間分別是一週及一年。這項治療不但改善了頑固性的心衰竭，還幫助了心房顫動的控制。第一位病患在11個月的追蹤內未再發生心房顫動，第二位病患在6個月的追蹤內，陣發性心房顫動的發作次數也明顯減少。心房顫動的控制得以進步的機轉可能是由於在放置心臟再同步化心律調節器後，心房之張力及大小減小所造成的結果。(中台灣醫誌 2006;11:50-5)

關鍵詞

心房顫動，雙腔心律調整器，心臟再同步化治療，鬱血性心衰竭

聯絡作者：張坤正

地址：403 台中市北區育德路2號

中國醫藥大學附設醫院 心臟內科

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