

The assessment of the long-term effects of elective CRT-D of coronary heart disease after PCI

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Abstract. – OBJECTIVE: The present study was planned to evaluate the long-term effects of elective cardiac resynchronization therapy devices (CRT-D) of coronary heart disease after percutaneous coronary intervention (PCI).

PATIENTS AND METHODS: We continuously selected 124 patients with chronic stable heart failure to undergo PCI, and were randomly divided into two groups viz. control group with 72 cases and observation group with 52 cases. The control group was given intensive drugs, while the observation group was treated with a combination of intensive drugs with CRT-D. Followed-up for three years and contrasted their effects.

RESULTS: The survival rate of the observation group was significantly higher than that of the control group, and its major adverse cardiac events (MACE) rate was observed to be lower than that of the control group. During the follow-up of the control group, LVEDd, pro-BNP and NYHA increased but LVEF decreased. On the other hand, in the observation group, LVEDd, LVEF, NYHA showed no significant changes, but pro-BNP revealed a significant increase. The physical health, mental health, social health and total score of the observation group were significantly higher than that of the control group.

CONCLUSIONS: Patients with chronic stable heart failure who have CRT-D implant testified after PCI could have significant improvement in long-term survival rate, better quality of life, improved cardiac function and reduction in the occurrence of MACE too.

Key Words:

Chronic stable heart failure, PCI, CRT-D, Survival rate, MACE, Cardiac function, Quality of life, Economic costs.

However, the prevalence of heart failure also grew in the recent past¹. The exploration of the ways to improve the quality of life and long-term prognosis of patients with heart failure is the focus of current research. Heart failure is the result of the decline of cardiac contractility and the disorder of electrical conduction². The neuroendocrine regulation theory is an important discovery of the pathogenesis of heart failure. Further, the intensive drug therapy put forward on the basis of the above theory greatly reduced the mortality rate of heart failure³. Cardiac resynchronization therapy (CRT) is an analog of a normal mechanical contraction and electrical conduction order of heart so as to make the heart recover its pump function to the maximum. Numerous studies have confirmed that CRT significantly improved cardiac function of patients with heart failure, prolonged survival and improved quality of life⁴⁻⁵. At present, clinical and randomized controlled study, in larger scale and closer to “objective world,” is conducted to evaluate the safety and effectiveness. Implantable cardioverter defibrillator (ICD) has absolute indications for patients at high risk of sudden death⁶. Heart failure is a high-risk factor for sudden death. Therefore, patients with indications are recommended that there should be a combination therapy of CRT and ICD, i.e., CRT-D⁷. After having the patients with chronic stable heart failure patients in our center, they underwent PCI, the study scheduled for CRT-D treatment, and followed-up for three years to analyze the long-term effect, so as to provide a reference for clinical application.

Introduction

Heart failure is the ultimate outcome of a heart disease. The application of early revascularization technology of acute myocardial infarction gradually improvised the success rates of heart patients.

Patients and Methods

Patients

We continuously selected 124 patients who were confirmed with chronic stable heart failure from January 2012 to January 2014 in our hospital. The

inclusion criteria were: 1. In-line with the diagnostic criteria of ischemic, at least 50% stenosis in coronary angiography, with PCI indications; 2. In stable condition within nearly a month; 3. To adhere to medication and regular follow-up; 4. In line with the criteria of CRT-D implantation. CRT referenced ACC/AHA/NASEPE standard of the 2008 version (8): NYHA with no limitation, left ventricular end diastolic diameter (LVEDd) ≥ 55 mm, left ventricular ejection fraction (LVEF) $\leq 40\%$, intraventricular conduction block, QRS wave duration ≥ 130 ms. ICD referenced the US HRS standard of the 2008 version (9): patients with a history of cardiac arrest, rapid ventricular tachycardia, ventricular fibrillation or high-risk factors. Excluded patients with dilated cardiomyopathy, valvular heart disease, pulmonary heart disease, congenital heart disease, atrial arrhythmia, poor compliance and imperfect clinical data, etc. The Ethics Committee of our hospital approved the study. The patients were informed and the signed consent was obtained from them or their families.

According to treatment methods, they were divided into 72 cases as the control group and 52 cases as the observation group. The control group had 40 males and 32 females; at the age of 56 to 78 with an average age of (64.5 ± 10.8) years old; 9 cases with target vessel located in the left anterior descending artery, 5 cases with left circumflex artery, 4 cases with left main coronary artery, 12 cases with right coronary artery, 35 cases with two vessel disease, 7 cases with three or more vessel disease; the number of implanted stents were 1 to 3 with an average number of (1.4 ± 0.6) stents; stent length was 10-30 mm with an average length of (16.5 ± 3.4) mm. The observation group had 29 males and 23 females; at the age of 53 to 76 with an average age of (64.0 ± 12.3) years old; 10 cases with target vessel located in the left anterior descending artery, 5 cases with the left circumflex artery, 2 cases with left main coronary artery, 10 cases with right coronary artery, 22 cases with two vessel disease, 3 cases with three or more vessel disease; the number of implanted stents were 1 to 3 with an average number of (1.2 ± 0.7) stents; stent length was 8-33 mm with an average length of (16.2 ± 3.6) mm. The baseline data of the two groups were comparable.

Methods

The same surgical and nursing team, in accordance with standard medical, completed the research for both two groups. They were treated with optimal medical therapy, including β -blockers, ACEI or ARB drugs, spironolactone, cardiotonic,

diuretic. The dose was gradually increased, and when it increased to the safe and tolerated upper dose, maintained the treatment; and antiplatelet drugs, which could reasonably control blood pressure, blood sugar, and blood lipids, etc. The control group adopted optimized drug treatment and follow-up was carried out, while the observation group scheduled for CRT-D implantation. Under the ultrasound guidance, found the optimal AVD and VV according to E, A peak size and mitral regurgitation case, which meant E, A peak separate, LVEF as high as possible, mitral regurgitation as little as possible, left ventricular filling time as long as possible. Adjusted the optimum pacing pulse width, threshold, impedance, perception and other parameters.

Observation Index

Compared survival rate and major adverse cardiac events (MACE) rate. Cardiac function indexes included LVEDd, LVEF, NYHA, pro-BNP. The quality of life indexes included economic cost and SF-36 scores. MACE events included malignant arrhythmias, sudden death, cardiac death, worsening heart failure, rehospitalization. LVEDd and LVEF were measured by modified Simpson method, while pro-BNP was measured by immunofluorescence double sandwich method. The kit was purchased from Beijing Zhongshan Golden Bridge Biotechnology Co. Ltd., while the ECL instrument was purchased from Beijing Six One Factory. The SF-36 scale was divided into physical health, mental health and social health. The higher the score was, the better the quality of life.

Statistical Analysis

SPSS 20.0 software (SPSS Inc., Chicago, IL, USA) was used for statistical analysis and data were expressed as mean \pm standard deviation. The comparison among groups was tested by *t*-test, comparison within group used variance analysis of repeated measure data, count data were expressed by the number of cases or a percentage (%). Further, the comparison among groups was tested by (corrected) χ^2 ; and $p < 0.05$ was considered that the difference was statistically significant.

Results

Comparison of Survival Rate and MACE Incidence Rate

The survival rate of the observation group was higher than that of the control group, and

Table I. Comparison of survival rate and MACE occurrence rate (cases (%)).

Groups	Cases	Survival rate	Malignant arrhythmias	Sudden death	Cardiac death	Worsening heart failure	Rehospitalization	MACE rate	Incidence
Control group	72	49 (68.1)	4 (5.6)	5 (6.9)	8 (11.1)	10 (13.9)	5 (6.9)	32 (44.4)	
Observation group	52	44 (84.6)	1 (1.9)	1 (1.9)	3 (5.8)	5 (6.9)	4 (7.7)	14 (26.9)	
χ^2		4.416	0.305	0.743	0.507	0.519	0.000	3.972	
p		0.036	0.581	0.389	0.476	0.471	1.000	0.046	

Table II. Comparison of cardiac function indexes.

Groups	LVEDd (mm)		LVEF (%)		NYHA		pro-BNP (pg/ml)	
	At the beginning	Three-year-follow-up	At the beginning	Three-year-follow-up	At the beginning	three-year-follow-up	At the beginning	Three-year-follow-up
Control group	57.6±2.3	62.3±2.6	34.5±3.6	26.9±3.0	2.6±0.5	3.7±0.8	1256±236	4528±524
Observation group	57.8±2.2	58.0±2.3	34.3±3.3	32.5±3.5	2.5±0.6	2.7±0.5	1302±240	2130±265
t	0.326	6.537	0.524	7.203	0.528	7.524	0.528	8.634
p	0.624	0.029	0.758	0.021	0.469	0.016	0.634	0.000

MACE rate was lower than that of the control group. The differences were statistically significant ($p < 0.05$). The comparison of the MACE, was not statistically significant ($p > 0.05$) (Table I).

Comparison of Cardiac Function Indexes

At the beginning, compared LVEDd, LVEF, NYHA and pro-BNP of the two groups, the differences were not statistically significant ($p > 0.05$); during the follow-up of the control group, LVEDd and pro-BNP increased, LVEF decreased, and NYHA increased, the differences were all statistically significant ($p < 0.05$). In the observation group, LVEDd, LVEF and NYHA had no significant change, pro-BNP decreased in comparison with the control group; during the follow-up of observation group, LVEDd and pro-BNP reduced compared with the control group, LVEF increa-

sed, NYHA improved, the differences were statistically significant ($p < 0.05$) (Table II).

Comparison of the Quality of Life

In comparison of economic cost between the two groups, the difference was not statistically significant ($p > 0.05$); the physical health, mental health, social health and total score were obviously higher than that of the control group, and the differences were statistically significant ($p < 0.05$) (Table III).

Discussion

Ischemic heart failure is a common result of myocardial hibernation, fibrosis, and infarction, etc.¹⁰. Heart failure with a history of myocardial infarction, due to the acute coronary occlusion,

Table III. Comparison of the quality of life.

Groups	Economic cost (ten thousand yuan)	Score of physical health	Score of mental health	Score of social health	Total score
Control group	20.8±3.6	31.7±5.8	22.4±4.6	23.5±4.8	68.9±10.5
Observation group	22.5±3.2	42.6±5.2	30.2±5.3	35.8±5.5	85.6±12.5
t	0.528	6.524	6.638	6.235	7.520
p	0.967	0.035	0.033	0.037	0.025

results in myocardial apoptosis or necrosis. Pathological remodeling after infarction, and elevated non-ischemic myocardium cells led to pathological hypertrophy or expansion¹¹. Stunning or hibernating myocardium without a history of myocardial infarction is the main mechanism leading to heart failure systolic dysfunction¹². Early PCI treatment could restore coronary perfusion, activate hibernating myocardium, improve cardiac function, and reverse the occurrence of ventricular remodeling and malignant ventricular arrhythmia¹³.

An earlier study¹⁴ observed that about 50 to 66% patients with chronic stable heart failure have atrioventricular and intraventricular conduction delay or block, which lead to multiple complications including atrioventricular, interventricular or left ventricular non-synchronous systolic movement, abnormal interventricular septal motion, systolic ejection time prolonged, diastolic filling time contraction and aggravated mitral regurgitation. Three-dimensional ultrasound speckle tracking technology has been observed to provide quantitative analysis for momentary uncoordinated movement of different regions more objectively, and allowed assessment of the survival state of myocardium¹⁵. CRT could better correct the invalid contract caused by interventricular electrical-mechanical dyssynchrony. The key of the technology lies in retrograding through the coronary sinus so as to pace left ventricle from the epicardium, with right ventricular pacing collectively leading to bi-ventricular synchronous pacing¹⁶. Companion trial pointed that¹⁷, CRT made the relative risk of heart failure death decrease by 51% (OR=0.49), but caused the risk of non-heart failure death (OR=1.15), which might be the reason why CRT total mortality could not be further reduced. CRT is not able to reduce mortality well while improving cardiac function. The summary found that CRT had potential risk of arrhythmia. The possible mechanisms could be pacing of right ventricular endocardium and left ventricular epicardium at the same time, leading to polymorphic ventricular tachycardia¹⁸. Further, the electrical pulse issued by left ventricular epicardial electrode once falls into “vulnerable period” of premature contraction of the ventricle, it might induce ventricular tachycardia and ventricular fibrillation¹⁹. These potential arrhythmia risks of CRT are decided by its own working principle, and it is difficult to fundamentally overcome. Thus, ICD implantation could be used as primary and secondary prevention measures applied to malignant ventricular arrhythmia events in patients with heart failure²⁰.

Conclusions

The survival rate of observation group was 84.6%, which was higher than the control group. So, medication alone cannot reverse ventricular remodeling, and CRT-D could delay the process of heart failure. Moreover, patients with chronic stable heart failure who have CRT-D implant testified after PCI could have significantly long-term survival rate, reduction in the prevalence of MACE, improvement in cardiac function and quality of life.

Conflict of interest

The authors declare no conflicts of interest.

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