CASE REPORT

Regular Treatment Strategy with a Large Amount of Carvedilol for Heart Failure Improves Biventricular Systolic Failure in a Patient with Repaired Tetralogy of Fallot

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Summary

It is widely known that β-blockers exert beneficial effects on non-ischemic and ischemic systolic heart failure (sHF) in nonstructural hearts. However, whether β-blockers exert similar effects on sHF associated with congenital heart disease (CHD), particularly in an anatomical right ventricle, remains under debate.

Here we report the case of an adult man with repaired tetralogy of Fallot suffering from biventricular heart failure. Treatment with carvedilol directly improved the systolic function of the right and left ventricles. This case report strongly suggests there is potential for carvedilol to exert a beneficial effect on heart failure in CHD. The appropriate titration of carvedilol and patient follow-up for long-term effects are important when treating adult patients with CHD with β-blockers.

Key words: Right ventricular failure, β-blockers, Adult congenital heart disease, Cardiac MRI

Carvedilol is a standard medication for chronic systolic heart failure in patients with nonstructural heart disease.1,2 However, it remains unclear whether carvedilol is effective in systolic heart failure (sHF), especially right heart failure associated with CHD.3 A 49-year-old male patient who had undergone an intracardiac repair for tetralogy of Fallot (TOF) at the age of 5 years developed severe biventricular systolic failure, which was a contraindication for additional surgical repair for right ventricular outflow tract restenosis (RVOTS) and residual ventricular septal defect (VSD). Therapy with carvedilol markedly improved the patient’s biventricular function, enabling the patient to undergo surgical repair. Cardiac magnetic resonance imaging revealed the improvement in right ventricular (RV) function occurred long after that in left ventricular (LV) function, suggesting that carvedilol exerted individual beneficial effects on each ventricle.

Case Report

A 49-year-old man was admitted to our hospital with dyspnea (New York Heart Association functional class III [NYHA-FC III]) and prominent pretibial edema. He had undergone an intracardiac repair of TOF in 1974 when he was 5 years of age. At the age of 42 years, he was diagnosed with premature ventricular contractions without sustained tachycardia (approximately 3000 times/day) and sought assistance at a university hospital for a detailed examination, including catheterization, which showed RV and LV dilatation associated with sHF and significant RVOTS with a trans-RVOTS-pressure gradient (T-RVOTS-PG) of 58 mmHg calculated from a systolic right ventricular pressure of 80 mmHg and systolic pulmonary arterial pressure of 22 mmHg. The patient was informed that another surgical repair for the RVOTS was required, but he refused to have the procedure. On admission to our hospital, his height and weight were 167 cm and 68 kg, respectively. His blood pressure was 124/90 mmHg, his heart rate (HR) was regular at 97 beats per minute, and the oxygen saturation of his arterial blood measured by pulse oximeter was 98% on room air. A chest radiograph showed moderate cardiomegaly (cardiothoracic ratio 58%) with lung congestion. An electrocardiogram showed sinus rhythm with a complete right bundle branch block and QRS duration of 202 msec. Laboratory tests revealed the brain natriuretic peptide (BNP) level had increased to 1014 pg/mL and the serum creatinine, gamma-glutamyl transpeptidase, and urinary acid levels were slightly elevated (1.14 mg/dL, 77 U/L, and 8.8 mg/dL, respectively), while all other lab values were normal. A transthoracic echocardiogram showed a dilated RV and LV with reduced systolic function. Trivial pulmonary regurgitation and trivial aortic regurgitation were documented, but there

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Figure 1. Four-chamber view of cMRI. A 4-chamber view of cMRI images at pretreatment and 3 years after carvedilol treatment are shown. Carvedilol significantly improved not only LVEF and LVEDVI, but also RVEF and RVESVI. cMRI indicates cardiac magnetic resonance imaging; LVEDVI, left ventricular end-diastolic volume index; LVEF, left ventricular ejection fraction; RVESVI, right ventricular end-diastolic volume index; and RVEF, right ventricular ejection fraction.

was no other detectable valvular regurgitation. Cardiac catheterization revealed the systemic blood flow index (QsI) was slightly decreased (2.3 L/minute/m²) with a small left-to-right shunt through the residual VSD (Qp/Qs = 1.1) and a peak-to-peak T-RVOTS-PG of 42 mmHg resulting from a right ventricular systolic pressure of 63 mmHg and pulmonary arterial systolic pressure of 21 mmHg. A coronary angiogram showed no significant coronary stenosis. Cardiac magnetic resonance imaging (cMRI) showed a markedly impaired ejection fraction (EF) and severe dilatation of both ventricles. The LVEF was 21% and RVEF was 30% (Figure 1). Episodes of tachyarrhythmia were not detected. Because of the poor biventricular systolic function, surgical repair of the RVOTS and VSD was contraindicated.

After stabilizing the patient’s heart failure with diuretics, the BNP had decreased to 360 pg/mL and carvedilol was administered and carefully titrated up to 25 mg. We set the target dose of carvedilol at 25 mg, because the HR has decreased and stabilized at 60-70 bpm. The cMRI showed near normalization of the LVEF (45%) and the LV cavity (LVEDVI = 109 mL/m²); however, the RVEF and the RV cavity showed little improvement (Figures 1, 2). The recovery of the RVEF was delayed but eventually reached 40%. The improvement in LVEF primarily occurred within 1 year of initiating carvedilol; however, recovery of the RVEF took longer (Figure 2). The QsI normalized (3.3 L/minute/m²) while the T-RVOTS-PG calculated from a systolic right ventricular pressure of 75 mmHg and systolic pulmonary arterial pressure of 16 mmHg, increased to 59 mmHg. Eventually, the patient clinically improved to NYHA-FC II. Because of the marked improvement, the RVOTS and VSD could then be surgically repaired, and the patient agreed to undergo the operation. After surgical repair, his LVEF and RVEF improved further.
Discussion

This case report demonstrates the effects of carvedilol for biventricular sHF in a patient with repaired TOF. Although the improvement in LV systolic function might have directly contributed to the improvement in RV systolic function through an LV-RV interaction, most of the improvement in the RV occurred long after that in the LV, strongly suggesting that most of the RV recovery can be attributed to carvedilol.

The use of carvedilol for the treatment of sHF associated with CHD has not been established, especially in an anatomical right ventricle. We reviewed the English literature for studies in which β-blockers were used to treat heart failure in adults with a history of CHD and found 6 reports that are summarized in the Table. In these reports, there are discrepancies in the effectiveness of β-blockers for sHF and right heart failure in adults with CHD. The discrepancies could be attributed to etiological inhomogeneity in CHD, improper evaluation of ventricular function (particularly RV function), insufficient dosage of β-blocker, and/or short follow-up periods. Of these 6 reports, only two showed the effectiveness of β-blockers on RVEF, and in both studies the target disease was re-
restricted to one specific CHD, transposition of the great arteries (TGA), the dosage of carvedilol was seemingly sufficient, the follow-up durations were at least longer than one year, and the assessment of RVEF was done with cMRI. Moreover, in the case of TGA, a systemic right ventricle might be present due to chronic ischemic stress as well as pressure overload.6,7

In our patient, the etiology of biventricular sHF was unclear, although ischemic stress might have been involved due to the use of an unestablished cardiopulmonary bypass system for open cardiac surgery in 1974. The patient’s history of premature ventricular contractions can account for only a small portion of the etiology of the sHF. Also, the pressure overload from the T-RVOTS-PG would have, to some extent, contributed to acceleration of the RV failure. Based on the HR records (Figure 2), the final dose of carvedilol (25 mg) was apparently sufficient.6,10 Since cMRI is the gold-standard for volumetric and functional evaluation of the RV as well as the LV,12,13 our assessment was quite reliable. Finally, long-term follow-up of the patient’s biventricular function with cMRI provided detailed images of the recovery of the biventricular systolic failure and suggests that RV recovery in response to carvedilol might take longer than LV recovery.

In conclusion, carvedilol has the potential to improve biventricular systolic function in patients with CHD; however, it may take 1-2 years for its beneficial effect to be detected. The dosage of β-blocker and the treatment duration are very important for improvement in sHF in adult CHD patients to occur. Additional studies should be conducted to confirm the beneficial effects of β-blockers and to evaluate which types of heart failure respond to β-blockers in patients with various types of CHD.

Disclosures

Conflicts of interest: None.

References


