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Case Report · **Open Access** ·

Is hydrotherapy an appropriate form of exercise for elderly patients with biventricular systolic heart failure?

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Abstract

Hydrotherapy (exercise in warm water) is considered to be a safe and beneficial method to use in the rehabilitation of stable heart failure patients, but there is little information on the effect of the increased venous return and enhanced preload in elderly patients with biventricular heart failure. We present a case of an elderly man who was recruited to participate in a hydrotherapy study. We compared echocardiographic data during warm water immersion with land measurements, and observed increases in stroke volume from 32 mL (land) to 42 mL (water), left ventricular ejection fraction from 22% to 24%, left ventricular systolic velocity from 4.8 cm/s to 5.0 cm/s and left atrioventricular plane displacement from 2.1 mm to 2.2 mm. By contrast, right ventricular systolic velocity decreased from 11.2 cm/s to 8.4 cm/s and right atrioventricular plane displacement from 8.1 mm to 4.7 mm. The tricuspid pressure gradient rose from 18 mmHg on land to 50 mmHg during warm water immersion. Thus, although left ventricular systolic function was relatively unaffected during warm water immersion, we observed a decrease in right ventricular function with an augmented right ventricular pressure. We recommend further investigations to observe the cardiac effect of warm water immersion on patients with biventricular systolic heart failure and at risk of elevated right ventricular pressure.

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1 Introduction

Studies have shown that hydrotherapy [exercise in warm water (34°C)] is a safe and beneficial method to use during the rehabilitation of stable heart failure patients.[1] The human genome has been designed for physical activity[2,3] and, because the buoyancy of the water facilitates exercise, hydrotherapy is considered to be an excellent form of exercise for patients suffering from disabilities that make exercise on land difficult.[4] However, whole body immersion causes a redistribution of blood from the periphery to the thoracic cavity, which could be a challenge for some patients.[5,6] Although we, and other research groups, have found beneficial acute hemodynamic effects and decreased sympathetic activity in patients with chronic heart failure (CHF) during warm water immersion (WWI),[5,7–9] there might be contraindications with this form of exercise, especially in patients with left and right ventricular systolic heart failure and pulmonary hypertension (PH).

Here, we present a case of an elderly man who was recruited to participate in a hydrotherapy study. This case highlights unresolved issues regarding recommendation of hydrotherapy for patients with biventricular heart failure and PH.

2 Case report

A 82-year-old man with CHF with etiology of ischemic cardiomyopathy was recruited to participate in a hydrotherapy study at Sahlgrenska University Hospital because of physical impairments that negatively affected his mobility.[1] Exclusion criteria were hypertension, primary valve disease, and pacemaker rhythm. The patient was in a stable condition without changes in medical treatment in the past two months. Regurgitations in the aortic, mitral, and tricuspid valve were all mild. Demographic data are presented in Table 1.

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Table 1. Demographic data of the patient.

Age (yrs)	82
NYHA class	III
Duration of heart failure (yrs)	14
Weight (kg)	73
Height (cm)	178
Heart rate (beats/min)	93
Systolic blood pressure (mmHg)	98
Diastolic blood pressure (mmHg)	60
LVEF (%)	22
TV pressure gradient (mmHg)	18
Peak oxygen uptake (mL/kg per minute)	9.9
Beta blocker (metoprolol, mg)	50
ACEI (ramipril, mg)	10
Diuretics (furosemid, mg)	40
Statins (pravastatin, mg)	40
Anticoagulants (warfarin, mg)	2.5

ACEI : angiotensin-converting enzyme inhibitors; LVEF: left ventricular ejection fraction; TV: tricuspid valve.

Written informed consent was obtained from the patient, and the study was approved by the ethics committee at the University of Gothenburg. The patient was monitored by electrocardiography and examined while standing in a slightly tilted position both on land and in a swimming pool for 20–30 min with the water level up to his sternal notch. Transthoracic echocardiography examinations were performed using Siemens Sequoia 512 with a 3v2c transducer (Mountain View, CA, USA), and data were stored digitally on magnetic optical disks. To protect the probe from water, the transducer was placed in a latex stocking. In accordance with the recommendations of the American Society of Echocardiography, left ventricular ejection fraction (LVEF) was calculated using the method of discs, modified Simpson rule.[10] Ventricular long axis function was assessed with M-mode[11] and pulsed-wave tissue Doppler imaging.[12] With the exception of LVEF, measurements were averaged from at least three heart beats.

We compared echocardiographic data in the swimming pool with land measurements and observed small increases in systolic LV function: stroke volume increased from 32 mL to 42 mL, cardiac output from 3.0 L/min to 3.5 L/min and LVEF from 22% to 24% (land *vs*. WWI). LV systolic velocity increased from 4.8 cm/s to 5.0 cm/s and LV atrioventricular plane displacement from 2.1 mm to 2.2 mm (land *vs*. WWI).

By contrast, we found a decrease in right ventricular (RV) function: RV systolic velocity decreased from 11.2 cm/s to 8.4 cm/s and lateral RV systolic atrioventricular plane displacement from 8.1 mm to 4.7 mm (land *vs*. WWI). The tricuspid pressure gradient rose from 18 mmHg on land to 50 mmHg during WWI. The heart rate decreased from 93 beats/min to 83 beats/min (land *vs*. WWI).

The patient reported well-being during the WWI with no increase in breathlessness. However, he felt very cold for several hours after immersion and this prevented him from participating in the scheduled hydrotherapy sessions.

3 Discussion

During WWI, beneficial hemodynamic effects have been observed in patients with CHF,[5,7–9] most likely as a result of reduced sympathetic activity,[8] peripheral vasodilatation and reduction in systemic vascular resistance.[9] Conversely, a few patients with LV heart failure have shown a decrease in stroke volume during WWI.[5] To our knowledge, this is the first case to observe the effect of WWI in a patient with both right and left ventricular systolic dysfunction.

The elevated RV pressure during WWI in this patient with biventricular failure is an unfavorable response that should be avoided, since this could trigger pulmonary embolism. Theoretically, the elevated pressure during WWI in this patient might be caused by enhanced pulmonary blood flow due to increased venous return. In combination with backward failure of the left ventricle, this could lead to an increase in pulmonary vascular resistance and worsening in RV systolic heart failure.[13] Therefore, it appears that the right ventricle failed to generate enough pressure to overcome RV afterload and thus resulted in further decompensation.

Although RV dysfunction has been shown to be a strong predictor of adverse outcome independently of LV function,[14] relatively little is known about the mechanism of RV failure.[15] The combination of increased LV and decreased RV function, together with elevated pulmonary pressure during WWI in this present case, is confusing. It could be explained by decreased systemic vascular resistance in the aorta, caused by the thermally mediated vasodilatation in combination with a reduced heart rate. However, in this case, the increased flow in the right ventricle was not followed by a compensatory reduction in pulmonary vascular resistance.

In conclusion, the presented case questions whether hydrotherapy is contraindicated in patients with PH and significantly impaired RV systolic function. The impact of WWI on biventricular systolic dysfunction and PH has not previously been investigated and this issue warrants further studies.

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