〈Original Article〉

# Medium-term effect of dance exercise rehabilitation in a heart failure patients' group at maintenance phase

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**Summary** This study prospectively assessed the effect of dance exercise rehabilitation in 16 patients with heart failure who completed the recovery-period cardiac rehabilitation from July, 2015 to December, 2016 and participated dance exercise rehabilitation for more than 1 year in the maintenance period. Once a week, the study patients underwent the group dance therapy at the cardiac rehabilitation center. They also received a DVD to instruct the exercise therapy at home. The assessments were conducted at the initiation of maintenance-period rehabilitation and 1 year after the initiation of supervised cardiac rehabilitation. The mean peak oxygen uptake ( $VO_2$ ) at one year later was significantly increased ( 23.2 ± 3.9 to 24.6 ± 3.9 mL/min/kg; $p < 0.05$ ). No specific changes in the results of blood test or body composition analysis were observed. No adverse event, such as cardiovascular event or readmission, was occurred. The results of this study demonstrated that exercise tolerance might be improved by continuing cardiac rehabilitation with dance exercise in the maintenance-period.

**Key words:** Dance exercise rehabilitation, peak $VO_2$, anaerobic threshold, heart rate

## Introduction

Cardiac rehabilitation in Japan was first established as an acute-phase management and short-term intervention in patients with myocardial infarction. Owing to the accumulated data, nowadays cardiac rehabilitation is regarded as a total program to improve quality of life and prognosis and applied to patients with other cardiac diseases[1,2]. Since 2006, the health insurance coverage for cardiovascular rehabilitation has been calculated and defined as follows: 1) 1 unit, 20 minutes and 205 points; 2) up to 6 units per day; and 3) within 150 days after the

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initiation of cardiac rehabilitation. Cardiac rehabilitation varies; aerobic exercise using bicycle ergometer, walking and aerobic dance are employed in many medical facilities. In 2014, our facility established cardiac rehabilitation with supervised exercise therapy, including aerobic exercise by using equipment and resistance training. We have previously reported the exercise intensity and safety of group exercise therapy that incorporated dance exercise in cardiac disease patients during the maintenance period after the end of the health insurance coverage period[3]. This study report aimed to assess the improvement of exercise tolerance index in the medium term, such as one year.

## Materials and methods

This study included 16 patients ( 6 men, 67.5 ± 8.8 year-old; 10 women, 71.2 ± 4.1 year-old ) who underwent supervised cardiac rehabilitation for 150-days between July, 2015 and December, 2016 at our institution. All patients underwent the cardiac exercise testing ( CPX ) and took blood samples three times, before the initiation of 150-day cardiac rehabilitation, after the 150-day cardiac rehabilitation, and one year after the initiation of 150-day cardiac rehabilitation. The blood tests analyzed brain natriuretic peptide ( BNP ), total cholesterol ( T-CHO ), high-density lipoprotein ( HDL ), low-density lipoprotein ( LDL ), and triglycerides ( TG ). Strength Ergo 8 ( Fukuda Denshi, Co., Ltd, Tokyo, Japan ) was employed for the CPX. After an initial four-minute rest on the ergometer and four-minute warm-up, the patients underwent the CPX at a gradually increasing intensity by 10W at one-minute intervals. The expired gas analysis was performed throughout the CPX on the breath-by-breath basis. Oxygen uptake ( $VO_2$ ) and carbon dioxide production ( $VCO_2$ ) and minute ventilation ( VE ) were recorded during exercise; the obtained data, at 3-second intervals, were averaged by 8 points. Additionally, 12-lead electrocardiography ( ML-5000, Fukuda Denshi Co., Tokyo, Japan ) continuously monitored heart rate (HR) and ST changes.

The professional dance teachers instructed the study patients before the initiation of group dance exercise; they underwent dance exercise three times in 60 minute exercise therapy. Statistical analysis was performed using SPSS Statistics 24.0J. The Bonferroni method was employed to compare the differences in each parameter. Statistical significance was set at $p < 0.05$.

### *Ethics*

The present study was performed in accordance with the ethical principles set forth in the Declaration of Helsinki. The study protocol was reviewed and approved by the Institutional Review Board of the Iwatsuki-Minami Hospital; then, it was implemented in compliance with the Personal Information Protection Law.

## Results

### *1) Comparisons between before the initiation and after 150-day supervised cardiac rehabilitation*

The weight was significantly reduced ( 61.4 ± 10.8 kg to 60.4 ± 10.7 kg, p = 0.004 ). Peak oxygen uptake ( peak $VO_2$; 21.2 ± 3.7 to 23.2 ± 3.9 mL/min/kg, p = 0.049 ), the anaerobic threshold ( AT ) level ( 14.3 ± 2.8 to 16.0 ± 2.3 mL/min/kg, p = 0.003 ),

Table 1 Mean value and standard deviation in each parameter

| mean±SD | pre reha | post rehha | post one year |
|---|---|---|---|
| body weight ( kg ) | 61.4±10.8 | 60.4±10.7 | 60.3±10.5 |
| AT ( mL/min/kg ) | 14.3±2.8 | 16.0±2.3 | 16.5±2.5 |
| Peak $VO_2$ ( mL/min/kg ) | 21.2±3.7 | 23.2±3.9 | 24.6±3.9 |
| VE/$VCO_2$ slope | 28.3±5.1 | 26.0±6.3 | 24.0±5.4 |
| Peak WR ( watt ) | 95.6±16.0 | 95.4±16.4 | 92.1±18.0 |
| $\Delta VO_2/\Delta WR$ ( mL/min/watt ) | 9.6±1.6 | 10.9±1.8 | 11.1±1.7 |
| BNP ( pg/dL ) | 87.8±84.0 | 72.1±41.0 | 73.2±63.8 |
| T-CHO ( mg/dL ) | 159.0±15.7 | 162.4±19.0 | 170.9±21.3 |
| HDL ( mg/dL ) | 55.1±17.7 | 52.8±14.7 | 58.1±21.9 |
| LDL ( mg/dL ) | 84.8±12.2 | 84.1±10.1 | 99.6±16.6 |
| TG ( mg/dL ) | 126.1±132.2 | 134.8±138.5 | 128.6±118.6 |

Table 2 Multiple comparison test results of the mean in each parameter

| p-value | pre reha vs. post reha | pre reha vs. post one year | post reha vs. post one year |
|---|---|---|---|
| body weight ( kg ) | 0.004 | 0.091 | 0.782 |
| AT ( mL/min/kg ) | 0.003 | 0.001 | 0.066 |
| Peak $VO_2$ ( mL/min/kg ) | 0.049 | 0.002 | 0.042 |
| $VE/VCO_2$ slope | 0.073 | 0.012 | 0.128 |
| Peak WR ( watt ) | 0.889 | 0.192 | 0.291 |
| $\Delta VO_2/\Delta WR$ ( mL/min/watt ) | 0.001 | 0.001> | 0.455 |
| BNP ( pg/dL ) | 0.169 | 0.596 | 0.120 |
| T-CHO ( mg/dL ) | 0.363 | 0.031 | 0.283 |
| HDL ( mg/dL ) | 0.474 | 0.184 | 0.270 |
| LDL ( mg/dL ) | 0.892 | 0.056 | 0.031 |
| TG ( mg/dL ) | 0.372 | 0.674 | 0.287 |

and the ratio of increase in oxygen uptake to increase in work rate ( $\Delta VO_2/\Delta WR$; 9.6 ± 1.6 to 10.9 ± 1.8 mL/min/watt, p = 0.001 ) were significantly increased. No significant differences in BNP, T-CHO, HDL, LDL or TG, were observed.

*2) Comparisons between after the 150-day supervised cardiac rehabilitation and one year after the initiation of supervised cardiac rehabilitation*

Peak $VO_2$ ( 23.2 ± 3.9 to 24.6 ± 3.9 mL/min/kg, p = 0.002 ), AT ( 16.0 ± 2.3 to 16.5 ± 2.5 mL/min/kg, p = 0.001 ), and $\Delta VO_2/\Delta WR$ ( 10.9 ± 1.8 to 11.0 ± 1.7 mL/min/watt, p< 0.001 ) were significantly increased. In addition, T-CHO was markedly increased ( 162.4 ± 19.0 to 170.9 ± 21.3 mg/dL, p = 0.031 ).

*3) Comparisons between before the initiation of 150-day supervised cardiac rehabilitation and one year after the initiation of supervised cardiac rehabilitation*

Peak $VO_2$ ( 21.2 ± 3.7 to 24.6 ± 3.9 mL/min/kg, p = 0.042 ) and LDL ( 84.8 ± 12.2 to 99.6 ± 16.6 mg/dL, p = 0.031 ) were markedly increased.

## Discussion

The effect of maintenance-phase cardiac rehabilitation in the I and II phases has been already acknowledged[4,5,6,7], which improves depression and skeletal muscle abnormality caused by the following independent prognostic factors, exercise tolerance, exercise cardiac pump function, vascular endothelial function, autonomic balance, chemoreceptor reflex, and cardiac disorder. Subjective symptoms are alleviated and activity of daily living and quality of life are improved by cardiac rehabilitation. Various mechanisms, such as reduction of risk factors and cytokine, and improvement of thrombosis, stabilization of atheroma, and anti-arteriosclerotic effect, contribute to prognostic improvement. Belardinelli et al.[8] demonstrated that, in their randomized

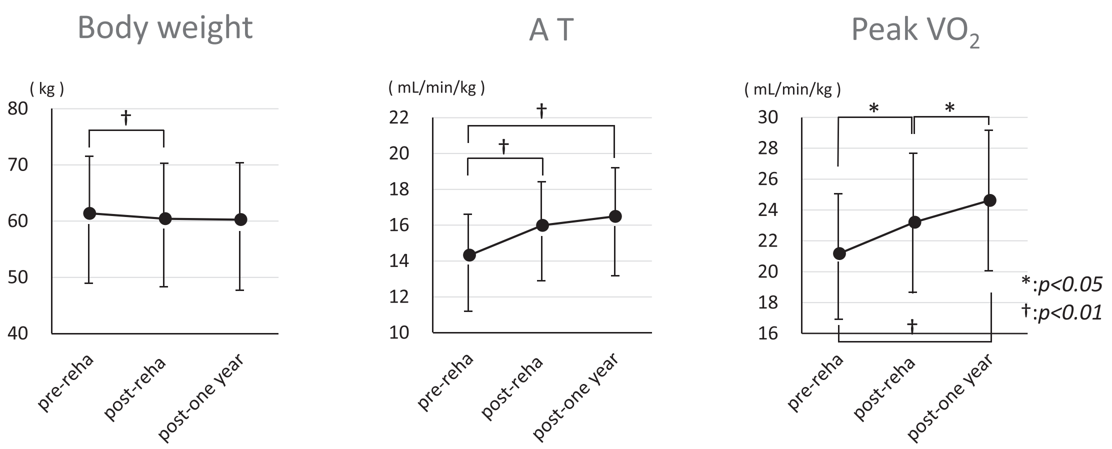


Fig. 1 Changes in body weight ( kg ), anaerobic threshold ( AT, mL/min/kg ) level, and peak oxygen uptake ( peak $VO_2$, mL/min/kg ) at before the initiation ( pre-reha ) and after 150-day supervised cardiac rehabilitation ( post-reha ), and one year after the initiation of cardiac rehabilitation ( post-one year ).

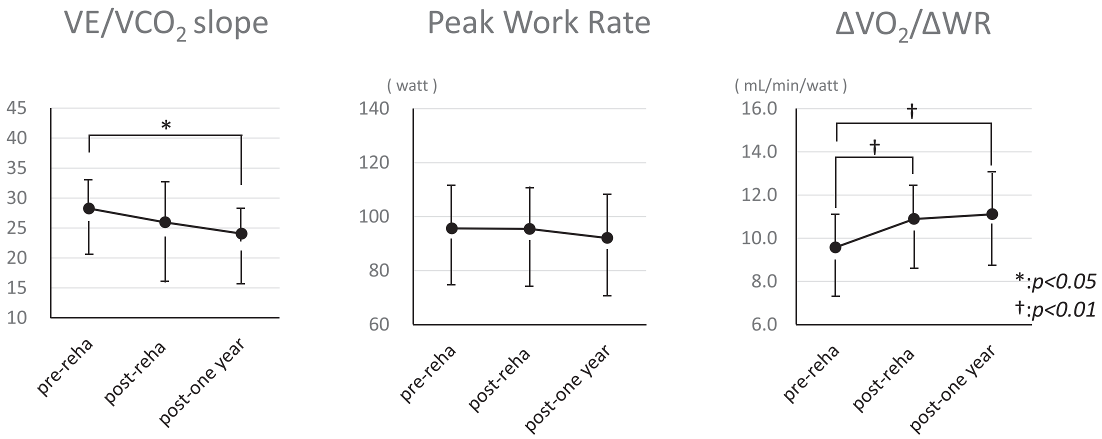


Fig. 2 Changes in minute ventilation ( VE ) / carbon dioxide production ( $VCO_2$ ) slope ( VE/ $VCO_2$ slope ), peak work rate ( WR, watt ), and the ratio of increase in oxygen uptake to increase in work rate ( $\Delta VO_2/\Delta WR$, mL/min/watt ) at before the initiation (pre-reha) and after 150-day supervised cardiac rehabilitation ( post-reha ), and one year after the initiation of cardiac rehabilitation ( post-one year ).

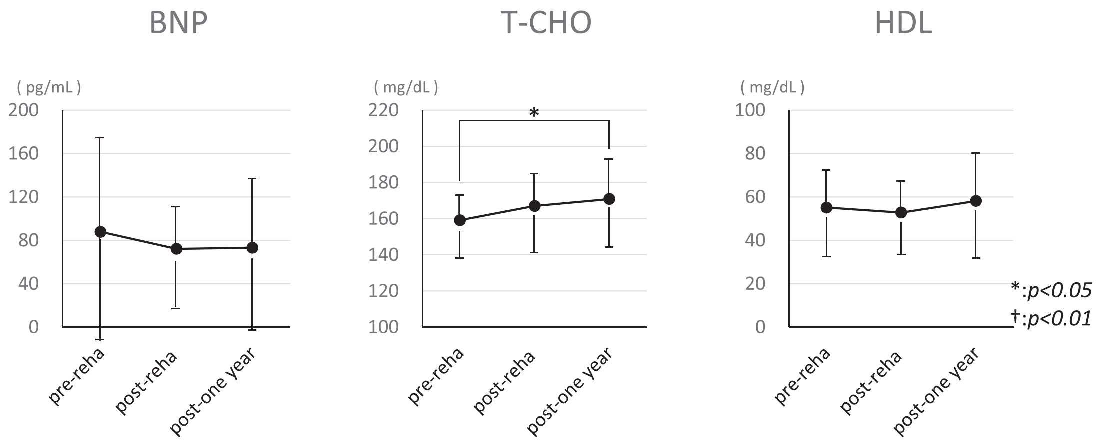


Fig. 3 Changes in brain natriuretic peptide ( BNP, pg/mL ), total cholesterol ( T-CHO, mg/dL ), HDL, high-density lipoprotein ( HDL, mg/dL ) at before the initiation ( pre-reha ) and after 150-day supervised cardiac rehabilitation ( post-reha ), and one year after the initiation of cardiac rehabilitation ( post-one year ).

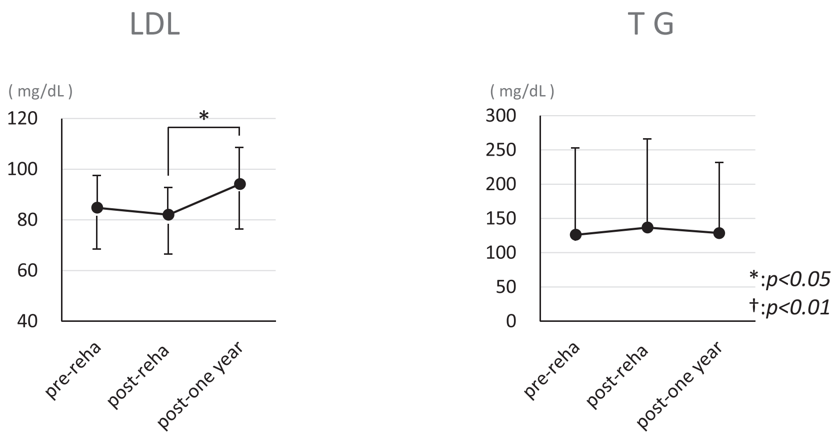


Fig. 4 Changes in low-density lipoprotein ( LDL, mg/dL ) and triglycerides ( TG, mg/dL ) at before the initiation ( pre-reha ) and after 150-day supervised cardiac rehabilitation ( post-reha ), and one year after the initiation of cardiac rehabilitation ( post-one year ).

controlled trials of the patients with chronic heart failure, the exercise therapy-administered group had less hospitalization due to the recurrence of heart failure and cardiac accidents than the non-administered group. In particular, the rate of cardiac death was decreased by approximately 23 %. They also suggested that the effect of cardiac exercise therapy be equivalent to that of β-blockers.

The results of our study also demonstrated the significant improvement in various parameters and exercise tolerance in the 150-day supervised exercise therapy (the I and II phases) as follows: weight, 61.4 ± 10.8 kg to 60.4 ± 10.7 kg ($p < 0.04$); AT, 14.3 ± 2.8 to 16.0 ± 2.3 mL/min/kg ($p < 0.003$); peak $VO_2$, 21.2 ± 3.7 to 23.2 ± 3.9 mL/min/kg ($p < 0.049$); and $\Delta VO_2/\Delta WR$, 9.6 ± 1.6 to 10.9 ± 1.8 mL/min/watt ($p < 0.001$). Moreover, the results of one year after the initiation of cardiac rehabilitation indicated the improvement of exercise tolerance in the chronic phase: AT, 14.3 ± 2.8 to 16.5 ± 2.5 mL/min/kg ($p < 0.001$); peak $VO_2$, 21.2 ± 3.7 to 24.6 ± 3.9 mL/min/kg ($p < 0.002$); VE/VCO2 slope, 28.3 ± 5.1 to 24.0 ± 5.4 ($p < 0.012$); and $\Delta VO_2/\Delta WR$, 9.6 ± 1.6 to 11.1 ± 1.7 mL/min/watt ($p < 0.001$). One study in the patients with ischemic heart disease, including ST elevation/ non ST elevation myocardial infarction and coronary artery bypass graft, demonstrated that the importance of cardiac rehabilitation in order to reduce cardiovascular hospitalizations and cardiovascular mortality during a long-term follow-up[9]. Of our 16 patients, none was readmitted; this result also supports the effectiveness of long-term cardiac rehabilitation.

Our cardiac rehabilitation program, such as group dance exercise rehabilitation, is extremely rare in Japan. According to a survey by the Central Social Insurance Medical Council in 2005, only 4 % or less of the patients with heart diseases underwent maintenance-period cardiac rehabilitation. Our further task will be how to promote the dance exercise rehabilitation program to the local communities.


## Conflicts of interest: Nil

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