Case Report

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Rehabilitation for Heart Transplant Recipients with Hemiplegic Comorbidity

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편마비를 동반한 심장 이식수술 환자들의 심장재활

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Abstract

Heart transplantation (HT) currently has a 5-year survival rate over 70%. However, even after successful HT, stroke is a major cause of morbidity and mortality. We described three cases of HT recipients with preoperative and postoperative hemiplegia. In the first case, stroke occurred 2 weeks after HT. In the other two cases, they had prior valve disease and myocardial infarction respectively and stroke occurred before receiving HT. Despite hemiplegic comorbidity, they all completed cardiac rehabilitation (CR) in accordance with physical function, showing improvements in oxygen uptake, metabolic equivalents or workload at follow up. Although neurological sequelae make it difficult to participate in exercise therapy as well as CR, comprehensive rehabilitation, including both cardiopulmonary and resistance training tailored to individual physical function, can prevent additional risks in terms of function and health. So, CR should be recommended not only for usual cardiac surgery patients but also for pre-, post- HT stroke and amputation patients.

Key Words

Heart transplantation, Cardiac rehabilitation, Hemiplegia

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Introduction

Heart transplantation (HT) is the optimal therapy for end stage heart failure (HF) that does not respond to medical treatment. With advances in infection prophylaxis and surgical techniques, HT currently has a 5-year survival rate of > 70% [1]. Stroke is one of the major causes of mortality in patients even after such successful HT. Perioperative cerebrovascular complications are more common after HT than after other routine cardiac operations [1]. Moreover, stroke in heart recipients is more common than that in liver or bone marrow recipients [2].

Not only HT recipients, patients with severe HF who are awaiting HT are also at risk of cerebrovascular events. Although left ventricular assist devices (LVADs) are used as a bridge therapy before HT, they are associated with a 5.5% annual incidence of stroke [3]. In patients with HF with and without atrial fibrillation, the average incidence rate of stroke per year was reported to be 1.6% and 1.2%, respectively [4].

Stroke before and after HT is a comorbidity with significant impact on subsequent poor functional outcomes, as well as mortality. There are prior reports of stroke rehabilitation after HT or CR of HF patient with stroke history [5,6]. To the best of our knowledge, this is the first report of successful CR in three HT recipients with preoperative and postoperative hemiplegia as a comorbidity.

Case Reports

1) Clinical case 1

This case involved a 59-year-old man who was admitted to 'A' hospital because of exertional dyspnea. His diagnosis was three-vessel coronary artery disease (CAD) and dilated cardiomyopathy with a left ventricular ejection fraction of 10%. He underwent coronary bypass surgery; however, his cardiac function worsened and heart transplantation (HT) was subsequently needed. Two weeks after HT, left-sided weakness occurred due to right anterior cerebral artery infarction. He was referred to our hospital for cardiac rehabilitation (CR) and stroke rehabilitation with a sequela of left foot drop. He started electrocardiography (ECG)-monitored aerobic exercise training, and the functional electrical stimulation (FES) device was applied to the tibialis anterior during gait training. The exercise intensity was set at a rate of perceived exertion (RPE) of 13–14 for 30 min per one session. Exercise was performed twice a day, 5 days a week, for 12 weeks. The treadmill exercise began at a speed of 1.3 km/h without any inclination. As a result of the 12-week program, He was able to perform aerobic training in treadmill at a speed of 3.5 km/h with 6% inclination. His peak oxygen uptake (peak VO_2) during cardiopulmonary exercise (CPX) test improved from 11.9 to 15.0 mL/kg/min and the peak metabolic equivalents (METs) improved from 3.4 to 4.3. No adverse events were observed throughout the CR program.

2) Clinical case 2

This case involved a 54-year-old woman on warfarin who had previously undergone aortic valve replacement (AVR), mitral valve replacement (MVR) and a maze procedure at 'B' hospital, and was diagnosed with right middle cerebral artery infarction 14 years apart. A year after stroke, she was hospitalized because of newly developed dyspnea. As echocardiography showed prosthetic valve failure, re-do valve replacement was performed; however, she was required a central extracorporeal membrane oxygenation (ECMO) since postoperative low cardiac output syndrome developed. Nevertheless, deteriorated heart function did not improve and HT was needed. One month after HT, an obstructive lesion of the left anterior descending artery was discovered on routine angiography, and coronary intervention was performed. She was referred to our hospital for CR and stoke rehabilitation for persisting left-sided weakness as a stroke sequela. Because her physical function was not sufficient for a treadmill exercise, she

started ECG-monitored aerobic exercise training on a ergometer. Furthermore, she could not maintain seated position, so she had to exercise on the recumbent ergometer (JR-3000, JNB Sports, South Korea). This product did not provide dynamics-related information such as kilopond or watt, and had resistance level of its own setting. The exercise intensity was set at RPE 15-16 for 30 min per session, twice a day, 5 days a week, for 6 weeks. As a result of the CR program, the revolutions per minute (RPM) increased from 30 to 50 and the resistance level of the ergometer increased from 1 to 3. No adverse effects or life-threatening cardiovascular events occurred throughout the course of the exercise program. She completed 36 hospital-based monitoring exercises and started home-based CR after discharge. She went through home-based recumbent ergometer exercise of 1 hour session, 5 times a week. At the 2-year follow up, her peak VO_2 showed an improvement from 10.1 to 12.6 mL/kg/min and the peak METs showed an improvement from 2.9 to 3.6.

3) Clinical case 3

This case involved a 53-year-old man who underwent percutaneous coronary intervention (PCI) with a diagnosis of MI at 'C' hospital. However, iatrogenic brachial artery injury at the time of PCI caused compartment syndrome and ischemic necrosis at right arm, followed by suspicious vasospasm of tibial artery and subsequent ischemic necrosis at left leg. The patient had to be transferred to another 'D' hospital for right trans-humeral amputation and left transtibial amputation surgery and subsequent left ventricular assisted device (LVAD) implantation. Two years after LVAD implantation, he developed left-sided weakness and was diagnosed with right middle cerebral artery infarction. His left upper limb and hip muscle strength was Fair+ according to manual muscle test grading, owing to remaining stroke sequelae. One year later, he underwent HT due to advanced heart failure despite LVAD. Finally, he was referred to our hospital for comprehensive rehabilitation including prosthetic rehabilitation, stroke rehabilitation and CR. After prosthetic training, he could walk with the aid of a walker along with the assistance of other person but he could not perform a treadmill exercise, so he started ECG-monitored exercise training on the recumbent ergometer. The exercise intensity was set at RPE 13 for 30 min per session, 5 days a week for 8 weeks. As a result of the 8-week program, the RPM increased from 30 to 40 and the resistance level increased from 1 to 3. Because his general condition was not sufficiently good for CPX test at admission, it was performed only once before discharge. A peak VO_2 of 8.1 mL/kg/min and METs of 2.3 were confirmed on CPX test. No adverse cardiovascular events occurred throughout the exercise program.

All the patients in present case report provided written informed consent for publication of the clinical details.

Discussion

Among our three cases, two patients had heart failure associated with CAD before ischemic stroke (Table 1). The pathophysiology of stroke in HF may be related to embolism and decreased cerebral perfusion. Left ventricular dysfunction causes blood stasis in the left atrium and left ventricle, and it increases the risk of thrombus formation leading to embolic stroke. In addition, hemodynamic decompensation may easily occur in HF patients due to impaired cardiac function, which can lead to decreased cerebral perfusion [7]. CAD and stroke also share many similar risk factors, including high blood pressure, diabetes, dyslipidemia, tobacco and obesity [8]. In two of our cases, CAD occurred before cerebral stroke. However in second case of present study, CAD was diagnosed at one month after HT during routine angiography and this suggests that the donor's coronary artery could have already had obstructive lesion.

In the second case, ischemic stroke occurred 14 years after MVR, AVR and Maze procedure. Valvular heart disease, especially mitral stenosis and prosthetic valve, increases the incidence of thromboembolism. Concomitant

Table 1. Characteristics of Patients

Characteristics	Case 1	Case 2	Case 3
Age (years)	59	54	53
Sex	male	female	male
Height (m)	1.70	1.60	1.72
Weight (kg)	58.3	66.0	65.9
BMI (kg/m^2)	20.1	25.7	22.2
LVEF (%) before HT	10	-	35
LVEF (%) after HT	58	58	65
Ischemic stroke location	Right ACA	Right MCA	Right MCA
Initial cardiac diagnosis	STEMI, DCMP	AS, MS Valve failure	STEMI, status post LVAD
Management before HT	CABG	AVR, MVR Maze OP	PCI, LVAD

BMI: body mass index, LVEF: left ventricular ejection fraction, HT: heart transplantation, ACA: anterior cerebral artery, MCA: middle cerebral artery, STEMI: ST-segment elevation myocardial infarction, AS: aortic valve stenosis, MS: mitral valve stenosis, DCMP: dilated cardiomyopathy, LVAD: left ventricular assist device, CABG: coronary artery bypass graft, AVR: aortic valve replacement, MVR: mitral valve replacement, OP: operation, PCI: percutaneous coronary intervention

atrial fibrillation (AF) also increases the risk of stroke in patients with valvular heart disease. Furthermore, sinus rhythm conversion of AF after classical Maze or variant Maze procedure varies widely and is reported between 44% and 95% [9]. For this reason, stroke in the second case is thought to be attributable to the history of valvular disease and incomplete sinus rhythm conversion.

Physical activity is generally recommended after cardiac surgery to improve quality of life and physical function as well as to prevent lung complication [10]. However, stroke is often associated with considerable skeletal muscle atrophy, leading to physical weakness and functional impairment. In this instance, it can be difficult to perform aerobic exercise of sufficient intensity and volume [8]. In our cases, weakness of the hemiplegic limb led to gait disturbance, which necessitated CR on an ergometer instead of a treadmill in two of our patients (Table 2).

There are some limitations in our case series. The patient in Clinical case 1 and 3 were not evaluated in the long term. Since they lived far from our clinic, they were lost to routine follow up. Also, the patient of Clinical case 3 was not able go through initial CPX test at admission because of medical condition. It could have been better if there were baseline CPX test to compare with the test result at discharge. In addition, in case of clinical case 2 and 3, the precise volume of exercise intensity was not obtained. The recumbent ergometer used for inpatient CR did not provide exact degree of resistance in standard unit such as kilopond or Newton. It would be more appropriate if the patients had undergone CR with a more standardized and quantified exercise protocol.

CR is already well known to be effective in improving exercise capacity and quality of life in patients with cardiac disease and patients receiving cardiac surgery as well [8,10]. All cardiac patients including HT recipient must be recommended and encouraged to participate in CR. Access

Table 2. Changes of Cardiorespiratory Fitness Level after Rehabilitation Including Aerobic Training

	Case 1	Case 2	Case 3
Content of CR	treadmill	bicycle ergometer	bicycle ergometer
Duration of CR per session	30 minutes	30 minutes	30 minutes
Sessions of CR	twice a day 5 days/wk, 12 wks	twice a day 5 days/wk, 6 wks	once a day 5 days/wk, 8 wks
Exercise Intensity (Borg RPE scale)	13-14	15-16	13
Exercise Intensity			
at initial	1.3 km/h, 0% inclination	Resistance level 1, 30 RPM	Resistance level 1, 30 RPM
at the end of session	3.5 km/h, 6% inclination	Resistance level 3, 50 RPM	Resistance level 3, 40 RPM
Changes of peak VO_2			
Initial peak VO_2	11.9	10.1	-
Final peak VO_2	15.0	12.6	8.1
Term between CPX	12 weeks	2 years	-
Changes of METs			
Initial METs	3.4	2.9	-
Final METs	4.3	3.6	2.3

CR: cardiac rehabilitation, wk: week, RPE: rate of perceived exertion, RPM: revolutions per minute, peak VO_2: peak oxygen uptake during cardiopulmonary exercise test, CPX: cardiopulmonary exercise test, METs: metabolic equivalents, The unit of VO_2 is mL/kg/min, 1 MET is equivalent to 3.5 ml/kg/min

to comprehensive rehabilitation programs that include both cardiopulmonary and resistance training tailored to individual physical function, can prevent additional risks in terms of function and health [8]. According to our experience and related articles, CR combined with conventional rehabilitation for stroke is effective in improving exercise capacity even in HT patients with hemiplegia as a comorbidity and must be recommended for all patients in need.

Conflict of Interests: The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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