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Case Report

Integrating Cardiac Rehabilitation with Neurorehabilitation in a Patient with Ischemic Stroke after Cardiac Surgery: a Case Report

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HIGHLIGHTS

- We report a case of ischemic stroke after cardiac surgery.
- There is no consensus on integration of cardiac rehabilitation with neurorehabilitation.
- Successful integrated rehabilitation contributes to enhancing patients' functional recovery.

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Conflict of Interest
The authors have no potential conflicts of interest to disclose.

ABSTRACT

Stroke and cardiac disorders are difficult to approach separately. Stroke survivors commonly have cardiovascular comorbidities and vice versa. These patients often need both neurorehabilitation and cardiac rehabilitation; therefore, this is an important issue in the rehabilitation process. However, no consensus has been reached on the integration of cardiac rehabilitation and neurorehabilitation. We report the case of a 52-year-old male patient who had ischemic stroke after mitral valvuloplasty. The patient underwent 3 weeks of inpatient neurorehabilitation, and then transited to 6 weeks of outpatient cardiac rehabilitation and occupational therapy. After 9 weeks of well-integrated rehabilitation, the patient experienced neurologic recovery and improvement in his cardiopulmonary fitness. Like this case, successful integrated rehabilitation will contribute to enhancing patients' functional recovery.

Keywords: Stroke; Cardiac Rehabilitation; Neurological Rehabilitation; Thoracic Surgery

INTRODUCTION

Stroke and heart disease share similar underlying pathophysiology and risk factors; diabetes, hyperlipidemia, smoking, physical inactivity, and obesity are known to increase the risk of both [1-3]. Stroke survivors commonly have cardiovascular comorbidities [4,5]. Heart disease and hypertension have been reported in up to 80% of stroke survivors. In addition, stroke is one of the major and common complications of cardiac surgery. Perioperative stroke with neurological deficits was reported to occur in 2% of patients who underwent cardiac surgery [6,7].

Accordingly, in many patients undergoing rehabilitation, stroke and heart disease occur simultaneously; some patients in neurorehabilitation can have heart diseases, and others in cardiac rehabilitation may have neurological deficits of stroke. Integration of cardiac rehabilitation and neurorehabilitation is important to facilitate and enhance functional recovery in these patients. Evidence that neurorehabilitation well integrated with cardiac rehabilitation might be feasible and beneficial in these patients has accumulated; however, no consensus has been reached yet on this issue [1,4,8,9].

We report the case of a patient with ischemic stroke after cardiac surgery who received a 9-week well-integrated rehabilitation that consisted of neurorehabilitation and cardiac rehabilitation.

CASE REPORT

A 52-year-old male who had been diagnosed with mitral valve regurgitation and followed up at a cardiology outpatient clinic visited the emergency department of a tertiary hospital because of sudden dyspnea and chest pain. He also presented generalized swelling, with pulmonary edema observed on his chest radiograph. Initial echocardiography revealed a chordae rupture that caused severe mitral valve regurgitation (grade 4); thereby hyperdynamic left ventricle (LV) (ejection fraction [EF] 75%) and new pulmonary hypertension (tricuspid valve regurgitation grade 1) developed. The patient underwent an emergent mitral valvuloplasty and was then admitted to the intensive care unit for postoperative care. Postoperative echocardiography revealed that the mitral valve regurgitation had disappeared (grade trace), with normal LV function (EF 57%) and no pulmonary hypertension (tricuspid valve regurgitation grade trace).

After the surgery, the symptoms of breathlessness and chest pain improved; however, the patient complained of newly developed weakness and paresthesia in his left hand. Brain magnetic resonance (MR) imaging revealed diffuse high signal intensity in the right frontoparietal cortices on diffusion-weighted imaging, with low signals on the apparent diffusion coefficient map (Fig. 1). On the following day, the patient underwent brain MR angiography, which revealed no abnormality in the intracranial and extracranial vessels. These results suggested acute embolic infarction in the right frontoparietal cortices, possibly caused by the cardiac surgery. Without any other complications, he was transferred to the general ward and began consultation-based rehabilitation sessions.

He had been previously healthy with asymptomatic mitral valve regurgitation and had worked as an electrician; therefore, despite his mild neurological impairment, he wanted

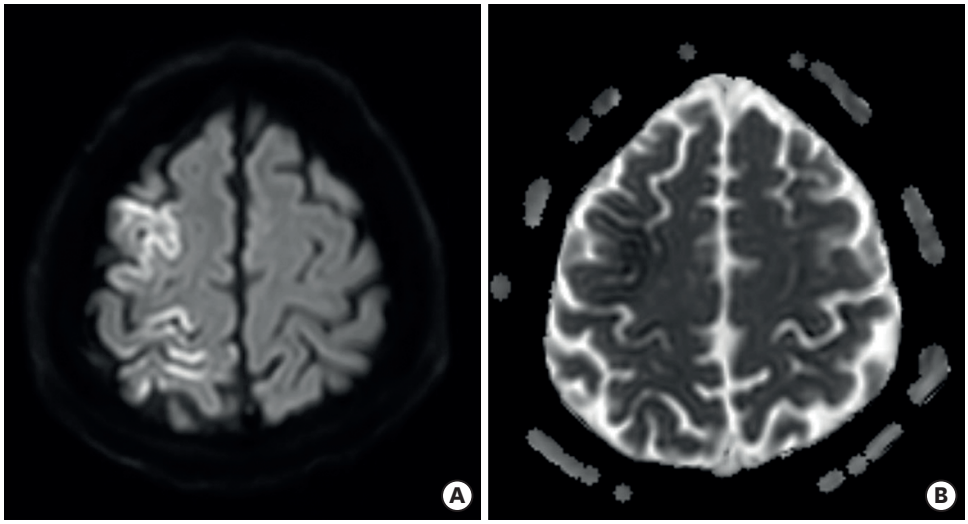

Fig. 1. The brain magnetic resonance imaging shows diffuse high signal intensity in right frontoparietal cortices (including primary motor/sensory cortices) on diffusion weighted imaging (A) with low signals on apparent diffusion coefficient map (B).

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Table 1. Assessments at the 3 time points of the rehabilitation programs

Variables	At transfer	3 weeks	At discharge	6 weeks	After the outpatient program
Type of service		Inpatient		Outpatient	
Contents of rehabilitation		PT, OT		CR, OT	
Functional assessments					
K-MBI	78				93
BBS	49		54		
FAC	2		5		5
FMA*	66/48				66/62
Grip strength (kg)*	40/26				42/29
BBT*			70/36		74/40
JHFT*			96/70		97/75
CPET					
VO_2 max (mL/[kg·min])			27.7		29.1
METs max			8.8		11.1
Resting HR			100		85
Peak HR			134		144
RER			1.10		1.20
VE/VCO_2			31.4		32.4

PT, physiotherapy; OT, occupational therapy; CR, cardiac rehabilitation; K-MBI, Korean-Modified Barthel Index; BBS, Berg Balance Scale; FAC, Functional Ambulation Categories; FMA, Fugl-Meyer Assessment; BBT, Box and Block Test; JHFT, Jebsen-Taylor Hand Function Test; CPET, Cardiopulmonary Exercise Testing; MET, metabolic equivalent task; HR, heart rate; RER, respiratory exchange ratio; VE/VCO_2, ventilatory efficiency to VCO_2 ratio.
*Presented from right to left.

to participate in an intensive rehabilitation program for returning to work. Ten days after the surgery, he was transferred to the department of rehabilitation medicine. At the time of transfer, a manual muscle test revealed that his strength was generally "normal," except for the "fair" left wrist and hand strength. His Korean-Modified Barthel Index (K-MBI) score was 78 of 100, with deductions in feeding, personal hygiene, bathing, dressing, ambulation, and stair climbing. Sensory ataxia was observed in his left hand; accordingly, the tests for the upper extremity functions (Fugl-Meyer Assessment [FMA], vibration threshold test, and grip strength test) revealed functional impairment on the left side (Table 1).

The patient had difficulties in ambulation and fine motor activities with left hand use, which would be major obstacles for returning to work. Thus, he participated in a stroke rehabilitation program rather than in cardiac rehabilitation to focus on facilitating neurological recovery. He received physiotherapy consisting of therapist-assisted gait and balance training, which were based on proprioceptive neuromuscular facilitation. Occupational therapy was also performed, mainly consisting of training of fine motor and bimanual activities involving the left hand. During the occupational therapy sessions, the patient strengthened his left upper extremity and practiced activities of daily living, such as dressing, sewing, and combing. After 3 weeks of inpatient rehabilitation, his ambulation and left wrist and hand weakness improved remarkably. At the time of discharge, he could go up and down the stairs independently, and his left wrist and hand strengths were assessed as better than "good."

After discharge to home, he underwent a 6-week outpatient rehabilitation program. The outpatient program included two sessions each of occupational therapy and cardiac rehabilitation per week (each for a total of 11 sessions). The outpatient occupational therapy sessions concentrated on a job simulation training, including fine motor activities directly associated with the tasks of an electrician, such as assembling pairs of bolts and nuts. The cardiac rehabilitation program consisted of not only aerobic exercise but also patient education and monitoring. The patient performed 10 minutes each of warm-up and cool-down exercises, and aerobic exercise using a treadmill or cycle. The exercise intensity

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was initially set with heart rate reserve of 55%, and then gradually progressed to 65%. Cardiopulmonary exercise testing (CPET) was performed just before the first and after the last cardiac rehabilitation session (Table 1).

Through the 9 weeks of the intensive rehabilitation program, the patient's cardiopulmonary fitness and neurological function improved. His K-MBI increased from 78 to 93, the FMA of the left side improved from 48 to 62, and the VO_{2max} increased from 27.7 to 29.1 mL/(kg•min). He planned to return to work and undergo follow-up at our rehabilitation medicine outpatient clinic in 3 months. The results of the assessments at the three time points of the rehabilitation program (at transfer, at discharge, and after the outpatient rehabilitation program) are presented in Table 1.

DISCUSSION

Stroke and cardiac disorders are difficult to approach separately for several reasons [5]. First, stroke and heart disease have similar etiologies and risk factors [1-3]. Second, perioperative stroke is also a major and common complication of cardiac surgery [6,7]. In addition, stroke survivors tend to maintain a sedentary lifestyle, which may contribute to additional cardiac problems [3]. Therefore, this is also an important issue in the rehabilitation process; some stroke patients undergoing neurorehabilitation may need cardiac rehabilitation for coexisting heart diseases, and other patients undergoing cardiac rehabilitation may benefit from neurorehabilitation for the neurological deficits of stroke. Briefly, effective integration of cardiac rehabilitation and neurorehabilitation is crucial for these patients; however, the knowledge and literature addressing this issue are limited. To our knowledge, this is the first report of the patient with ischemic stroke after valvuloplasty who received well-integrated rehabilitation consisting of neurorehabilitation and cardiac rehabilitation.

Our patient had a new-onset embolic stroke after mitral valvuloplasty. Before the surgery, he also complained of symptoms of acute heart failure due to severe mitral valve regurgitation. He underwent 9 weeks of inpatient and outpatient rehabilitation, which integrated neurorehabilitation and cardiac rehabilitation. Although his neurological impairment was mild, he began the inpatient program by focusing on neurorehabilitation. The decision was based on his need for improvement in ambulation and recovery of his left hand function to return to work, and on the fact that acute period after stroke is a period of enhanced neural plasticity. At discharge, the patient could ambulate independently; therefore, we prescribed cardiac rehabilitation instead of conventional gait training. He could actively participate in aerobic exercise and be educated on monitoring and the cautions of exercise in patients with heart disease. To be specific, the education sessions included the monitoring of heart rates and symptoms, which required attention during exercise, and the types of exercise to avoid. In addition, he continued outpatient occupational therapy with emphasis on job simulations for facilitating recovery of his left hand. After 9 weeks of well-integrated rehabilitation, the patient experienced neurologic recovery and improvement in his cardiopulmonary fitness.

In clinical practice, there have been previous studies that investigated a feasibility and effects of cardiac rehabilitation for secondary prevention of stroke [1,8,10]; however, no clear consensus has been reached yet on the integration of neurorehabilitation and cardiac rehabilitation in patients with stroke and cardiac disorders. Only a few suggestions are available. Given the limited resources and therapeutic time, clinicians can make

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individualized decisions on performing neurorehabilitation and cardiac rehabilitation in patients who need both. Patients with severe neurological injury should mainly receive neurorehabilitation, apart for those with mild impairment who could benefit from cardiac rehabilitation. A few previous studies also suggested that patients with mild physical and cognitive impairments are eligible for cardiac rehabilitation [2,3,8,9,11,12]. Furthermore, depending on the patient's progress, active transition between neurorehabilitation and cardiac rehabilitation can also be considered [13]. Specifically, patients in the acute period of stroke can take advantage of enhanced neural plasticity by focusing on neurorehabilitation. As time passes, these patients enter the chronic phase and mainly participate in cardiac rehabilitation for improving their cardiopulmonary health. However, it was recently reported that outpatient cardiac rehabilitation has been underutilized in Korea: only 1.5% of patients with acute myocardial infarction underwent outpatient program [14]. This report supports that outpatient cardiac rehabilitation needs to be promoted for maximizing functional recovery of certain patients.

In conclusion, the present case report describes the successful integration of cardiac rehabilitation and neurorehabilitation in a patient with ischemic stroke after cardiac surgery. After the 9-week rehabilitation program, the patient benefited from enhanced functional recovery. Like in this case, a well-integrated cardiac rehabilitation and neurorehabilitation will contribute to improved outcomes in a notable proportion of stroke survivors with cardiac disorders.

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