Yeungnam University Journal of Medicine
YUJM

Case report
eISSN 2384-0293
Yeungnam Univ J Med 2021;38(4):361-365
https://doi.org/10.12701/yujm.2020.00885

Safety and effectiveness of early cardiac rehabilitation in a stroke patient with heart failure and atrial fibrillation: a case report

Sang Cheol Lee[1], Eun Jae Ko[2], Ju Yeon Lee[1,3], Ae Lee Hong[1,3]

[1]Department of Physical Medicine and Rehabilitation, Ulsan University Hospital, University of Ulsan College of Medicine, Ulsan, Korea
[2]Department of Rehabilitation Medicine, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea
[3]Cardiac Rehabilitation Center, University of Ulsan College of Medicine, Ulsan, Korea

Received: December 21, 2020
Revised: February 2, 2021
Accepted: February 6, 2021

Corresponding author:
Eun Jae Ko, MD, PhD
Department of Rehabilitation Medicine, Asan Medical Center, University of Ulsan College of Medicine, 88 Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea
Tel: +82-2-3010-3912
Fax: +82-2-3010-6964
E-mail: ejko.amc@gmail.com

Stroke patients have reduced aerobic capacity. Therefore, intensive structured exercise programs are needed. We report the case of a patient with stroke and cardiac disease who underwent early inpatient cardiac rehabilitation (CR). A 38-year-old male patient with atrial fibrillation, heart failure, and cerebral infarction underwent a symptom-limited exercise tolerance test (ETT) without any problems on day 45 after admission. He completed a 2-week inpatient program and an 8-week home-based CR program. Follow-up ETT showed increased exercise capacity. The present case might be the first to report a safely performed CR program in a patient with stroke and cardiac comorbidity in Korea. Systematic guidance is needed for post-stroke patients to receive safe and effective CR for the secondary prevention of stroke and cardiovascular risk.

Keywords: Cardiac rehabilitation; Exercise; Heart failure; Stroke

Introduction

Stroke patients are predisposed to a sedentary lifestyle that leads to cardiorespiratory deconditioning, muscle atrophy, and further weakness [1]. The mean maximal oxygen uptake (VO_2 max) at 1 month after stroke has been reported to be approximately 60% of the normative values for sedentary healthy individuals, which is comparable to the previously reported age-adjusted VO_2 max at 1 month after myocardial infarction [2]. Patients with stroke reportedly have a lower aerobic capacity than patients with primary cardiac disease [3]. Furthermore, cardiac problems are often observed in patients with stroke. Among stroke survivors, approximately 28.8% present with coronary artery disease, and 16.5% have heart failure [4]. Patients with concomitant stroke and cardiac disease have lower aerobic capacity than patients with stroke alone [3]. Therefore, intensive structured exercise programs including aerobic and resistance training are needed for this group of patients. However, traditional stroke rehabilitation programs cannot provide sufficient exercise [1], and additional cardiac rehabilitation (CR) is needed.

Despite the importance of CR, the proportion of stroke patients enrolled in CR was 4.8% in a previous study [3]. To our knowledge, CR is not routinely indicated for individuals with stroke in Korea.

We report the case of a patient with stroke and cardiac disease who underwent early inpatient CR followed by home-based CR.

Case

A 38-year-old male patient who was a smoker (5 pack-years) and

had a history of unknown arrhythmia without medical treatment was admitted to the emergency room due to right hemiplegia. During the initial examination, the patient was stuporous with a Glasgow Coma Scale score of 7. He was diagnosed with infarction of the left middle cerebral artery (MCA) territory (Fig. 1A) with occlusion of the M1 segment of the left MCA (Fig. 1B). He had atrial fibrillation, heart failure with a left ventricular ejection fraction (LVEF) of 27% (Table 1), pulmonary edema, pleural effusion, and mild cardiomegaly (Fig. 2). He was admitted to the intensive care unit of the Department of Cardiology. He received a tracheostomy, mechanical ventilation, and additional medical treatment. He showed improvement in the LVEF from 27% to 47% on echocardiography and normal sinus rhythm on electrocardiogram (ECG) after treatment.

On day 37 after admission, the patient was transferred to the Department of Rehabilitation Medicine, where he was provided with stroke rehabilitation and CR. The Mini-Mental State Evaluation score denoting the cognitive function was 30. In the manual muscle test, the right upper extremity was graded as good in the proximal portion and fair in the distal portion. The right lower extremity was graded as good. The functional ambulation category (FAC) score was 4 and the Berg balance scale (BBS) score was 53. The modified Barthel index (MBI) score was 77. Speech evaluation showed anomic aphasia with an aphasia quotient (AQ) of 79. On day 38 after admission, the nasogastric tube was removed, and oral feeding was started after the videofluoroscopic swallowing study. The tracheostomy tube was also removed on day 43 after confirming that the patient had sufficient strength for coughing and sputum expectoration. He received physical therapy, occupational therapy, and speech therapy for stroke rehabilitation.

The first symptom-limited exercise tolerance test (ETT) was conducted on day 45 after admission (Fig. 3A). After 14 minutes and 48 seconds, the ETT was terminated upon patient's request due to leg discomfort. Using the Fitness Registry and the Importance of Exercise National Database (FRIEND) equation, the pre-

Table 1. Serial follow-up using transthoracic echocardiography

Variable	Day 2	Day 4	Day 11	Day 25	Day 51
Ejection fraction (%)	27	27	28	47	63
LV distance (mm)					
Diastolic	58	55	-	-	-
Systolic	53	52	-	-	-
Diastolic function					
E (m/sec)	0.8	-	-	-	-
E' (m/sec)	0.08	-	-	-	-
E/E'	11	-	-	-	-
Deceleration time (msec)	100	-	-	-	-
Thickness of IVS (cm)					
Systolic	1.1	-	-	-	-
Diastolic	1.0	-	-	-	-
LVEDV (mL)	188	149	143	125	136

LV, left ventricular; E, early ventricular filling velocity; E', peak annulus velocity during early filling; E/E', the ratio of the early ventricular filling velocity to peak annulus velocity during early filling; IVS, interventricular septum; LVEDV, LV end-diastolic volume.

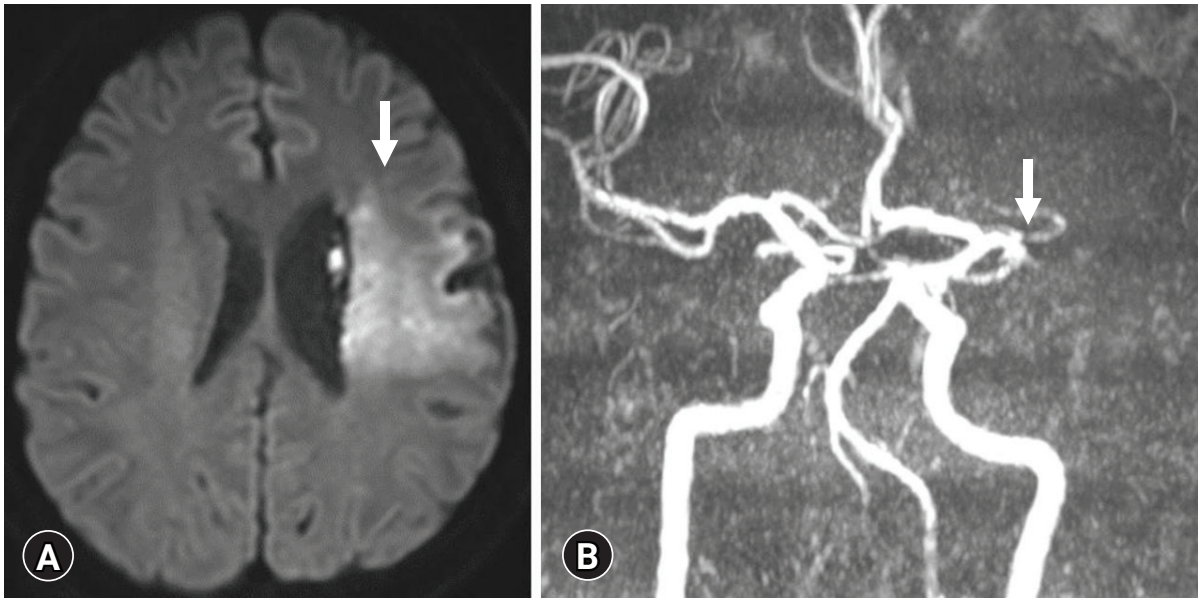

Fig. 1. (A) Brain magnetic resonance imaging shows infarction (arrow) of the left middle cerebral arterial territory (diffusion-weighted image, axial view). (B) Brain magnetic resonance angiography shows occlusion (arrow) of the M1 segment of the left middle cerebral arterial territory.

https://doi.org/10.12701/yujm.2020.00885

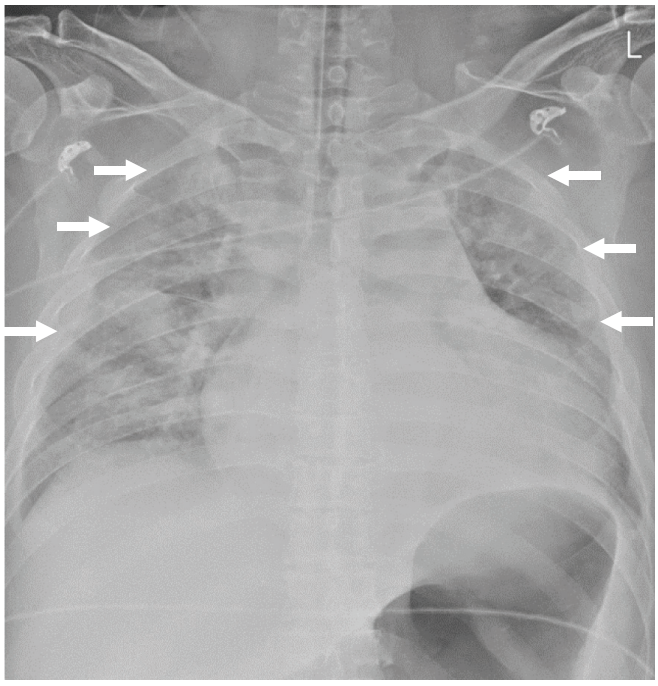

Fig. 2. Chest X-ray shows pulmonary edema, pleural effusion, and mild cardiomegaly (arrows).

dicted VO_2 max, which reflected age and weight, was 42.15 mL/kg/min [5]. The measured VO_2 max was 21.7 mL/kg/min (51.5% of predicted value), and there was no abnormality in exercise ECG and hemodynamic response. The patient participated in a CR program for 2 weeks (1-hour sessions five times per week) (Fig. 3B). An ECG-monitored exercise training with 4.6 metabolic equivalents (METs) was started, and the intensity was gradually increased. After 2 weeks, a follow-up ETT was performed, and the test was stopped after 15 minutes and 53 seconds upon patient's request. The VO_2 max improved from 21.7 to 27.3 mL/kg/min (from 51.5% to 64.8% of the predicted value) (Table 2). The patient also received an educational program about risk factor management, including smoking cessation and nutrition. Upon discharge (day 60 after admission), the BBS score changed from 53 to 56 (smaller than the minimal clinically important difference [MCID] of 12.5) [6], MBI score from 77 to 98 (larger than MCID of 20.1) [7], and AQ from 79 to 88.2.

The patient underwent a home-based CR program three times a week after discharge from the hospital for 8 weeks. After 8 weeks, a follow-up ETT was performed (Table 2). The test was stopped after 18 minutes and 30 seconds upon patient's request, and the VO_2 max showed further improvement (31.3 mL/kg/min, 74.3% of predicted value). Based on the guidelines of the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), risk stratification of the patient was changed from moderate risk at the first test to low risk at the follow-up ETT [8].

Fig. 3. (A) The photograph shows symptom-limited exercise tolerance test. (B) The photograph shows electrocardiogram-monitored exercise training.

Discussion

Herein, an inpatient CR program was initiated on day 45 after admission in a patient with atrial fibrillation, heart failure, and stroke. There were no adverse events such as worsening of heart failure, cardiac arrest, or death during the 2-week exercise training. Subsequently, the patient's exercise capacity and LVEF on echocardiography improved. A home-based CR program resulted in a further increase in exercise capacity.

Table 2. Hemodynamic results of symptom-limited exercise test

Variable	Day 45	Day 58	Day 105
Protocol	Modified Bruce	Modified Bruce	Modified Bruce
Metabolic equivalent	6.2	7.8	8.9
Maximal heart rate (beats/min)	162	162	164
Maximum blood pressure (mmHg)			
Systolic	152	161	179
Diastolic	61	65	69
Rate pressure product (mmHg·beats/min)	23,652	24,160	28,640
Borg scale of perceived exertion	17	17	18
VO_2 max (mL/kg/min)	21.7	27.3	31.3
Respiratory exchange ratio	1.22	1.26	1.13
Total exercise time	14 min	15 min	18 min
	48 sec	53 sec	30 sec

VO_2 max, maximal oxygen uptake.

Some previous studies have shown the effectiveness of CR in patients with stroke. Tang et al. [3] showed that a 12-month program providing aerobic and resistance training through a combination of supervised exercise sessions (once per week) and home exercise sessions (four times per week) improved the anaerobic threshold and VO_2 max in patients with concomitant stroke and cardiac disease and patients with stroke alone. These improvements were similar to the improvements observed in nonstroke participants. However, the study did not present any information regarding the interval between stroke and the beginning of CR. In another study [9], subjects having a transient ischemic attack or mild, nondisabling stroke within 12 months (mean of 11.5 weeks) were recruited to the outpatient CR program. Some of them had ischemic heart disease, but their percentages were not indicated. The 6-month CR program included 2-hour group sessions of risk factors, service education, and exercise training. The exercise training was performed on-site (50 sessions twice a week) or at home (at least four times a week). Upon program completion, a significant change of 2.04 METs (31.4%) was observed. Billinger et al. [10] studied the effect of an 8-week moderate-high aerobic exercise intervention in 10 patients with a diagnosis of stroke within 6 months (mean of 68.6 days) without any cardiac disease. There was a significant improvement in VO_2 max after the intervention. The results of our study are consistent with those of previous studies. However, an important finding of our study was that CR could be started quite early (day 45 after admission), considering the poor health condition of the patient.

Stroke patients in Korea generally receive stroke rehabilitation in both secondary and tertiary hospitals. These traditional stroke rehabilitation programs also include aerobic training but do not provide sufficient and maximal exercise because they are not based on ETT. They rather focus on motor recovery and gait exercise. Since stroke and cardiac diseases share many similar risk factors [1], intensive aerobic training, resistance exercise, and risk modification education are essential in stroke patients. If patients with stroke are provided with ETT and CR, the aerobic capacity and risk stratification of each patient will be calculated, leading to maximal, structured, and safe exercise programs. However, barriers to enhanced enrollment of stroke patients in CR include neurological and functional deficits such as hemiparesis and sensory ataxia, lack of a CR program mandate to include stroke patients, and personal perceived impact of stroke-related disability on participation [3]. Moreover, there is no indication of CR for stroke patients in the clinical practice guidelines for CR in Korea [11].

The safety of CR after acute cardiac disease has been suggested [12], but the safety of early CR in stroke patients has not been well elucidated. The present case is the first to report a safely performed CR program in a stroke patient with atrial fibrillation and heart failure in Korea. If a stroke patient has minor functional deficits as described in this case report (FAC 4 and lower extremity power good grade), CR provided with a traditional stroke rehabilitation program will lead to additional benefits. Systematic guidance is needed for post-stroke patients to receive safe and effective CR for the secondary prevention of stroke and cardiovascular risk.

Notes

Ethical statements

This retrospective study was approved by the Institutional Review Board (IRB) of Ulsan University Hospital (IRB No: 2021-01-024), and the requirement for informed consent from the patient was waived by the IRB.

https://doi.org/10.12701/yujm.2020.00885

Conflicts of interest

No potential conflict of interest relevant to this article was reported.

Author contributions

Conceptualization: all authors; Data curation, Visualization: SCL; Formal analysis: SCL, EJK; Methodology: EJK, JYL, ALH; Project administration: JYL, ALH; Investigation: SCL, JYL, ALH; Resources: JYL, ALH; Supervision: EJK; Writing-original draft: SCL; Writing-review & editing: EJK.

ORCID

Sang Cheol Lee, https://orcid.org/0000-0002-4773-5720
Eun Jae Ko, https://orcid.org/0000-0001-7198-5407
Ju Yeon Lee, https://orcid.org/0000-0001-9112-3978
Ae Lee Hong, https://orcid.org/0000-0001-8940-7285

References

1. Marzolini S. Integrating individuals with stroke into cardiac rehabilitation following traditional stroke rehabilitation: promoting a continuum of care. Can J Cardiol 2018;34(10 Suppl 2):S240-6.
2. Mackay-Lyons MJ, Makrides L. Exercise capacity early after stroke. Arch Phys Med Rehabil 2002;83:1697–702.
3. Tang A, Closson V, Marzolini S, Oh P, McIlroy W, Brooks D. Cardiac rehabilitation after stroke-need and opportunity. J Cardiopulm Rehabil Prev 2009;29:97–104.
4. Kesarwani M, Perez A, Lopez VA, Wong ND, Franklin SS. Cardiovascular comorbidities and blood pressure control in stroke survivors. J Hypertens 2009;27:1056–63.
5. Myers J, Kaminsky LA, Lima R, Christle JW, Ashley E, Arena R. A reference equation for normal standards for VO2 max: analysis from the fitness registry and the importance of exercise national database (FRIEND Registry). Prog Cardiovasc Dis 2017;60:21–9.
6. Song MJ, Lee JH, Shin WS. Minimal Clinically Important Difference of Berg Balance Scale scores in people with acute stroke. Phys Ther Rehabil Sci 2018;7:102–8.
7. Hong I, Lim Y, Han H, Hay CC, Woo HS. Application of the Korean version of the modified Barthel index: development of a keyform for use in clinical practice. Hong Kong J Occup Ther 2017;29:39–46.
8. American Association of Cardiovascular and Pulmonary Rehabilitation. Guidelines for cardiac rehabilitation and secondary prevention programs. Leeds: Human Kinetics; 2004.
9. Prior PL, Hachinski V, Unsworth K, Chan R, Mytka S, O'Callaghan C, et al. Comprehensive cardiac rehabilitation for secondary prevention after transient ischemic attack or mild stroke: I: feasibility and risk factors. Stroke 2011;42:3207–13.
10. Billinger SA, Mattlage AE, Ashenden AL, Lentz AA, Harter G, Rippee MA. Aerobic exercise in subacute stroke improves cardiovascular health and physical performance. J Neurol Phys Ther 2012;36:159–65.
11. Kim C, Sung J, Lee JH, Kim WS, Lee GJ, Jee S, et al. Clinical practice guideline for cardiac rehabilitation in Korea: recommendations for cardiac rehabilitation and secondary prevention after acute coronary syndrome. Korean Circ J 2019;49:1066–111.
12. Kim C, Kim DY, Lee DW. The impact of early regular cardiac rehabilitation program on myocardial function after acute myocardial infarction. Ann Rehabil Med 2011;35:535–40.