Clinical characteristics of functional recovery after coronary artery bypass graft surgery in Japanese octogenarians

RYO TOBITA1, KENTARO IWATA2, KENTA KAMISAKA3, SATOSHI YUGUCHI6, MASAYUKI TAHARA5, KESUKE OURA8, TOMOYUKI MORISAWA7, SATOKO OHHASHI9, MEGUMI KUMAMARU9, YUSUKE HANAFUSA10, MICHITAKA KATO11, MASAKAZU SAITO12, KOJI SAKURADA13, TETSUYA TAKAHASHI14,*

1) Department of Rehabilitation, Shiga University of Medical Science Hospital, Japan
2) Department of Rehabilitation, Kobe City Medical Center General Hospital, Japan
3) Rehabilitation Center, Kitano Hospital, The Tazuke Kofukai Medical Research Institute, Japan
4) Department of Rehabilitation, The Sakakibara Heart Institute of Okayama, Japan
5) Department of Rehabilitation, Higashi Takarazuka Satoh Hospital, Japan
6) Division of Rehabilitation, Fukuyama Cardiovascular Hospital, Japan
7) Department of Physical therapy, Faculty of Rehabilitation, Hyogo University of Health Sciences, Japan
8) Department of Rehabilitation, Kasukabe Chuo General Hospital, Japan
9) Department of Rehabilitation, Gunma Children's Medical Center, Japan
10) Department of Rehabilitation, Saitama Medical University International Medical Center, Japan
11) Department of Rehabilitation, Shizuoka Medical Center, Japan
12) Department of Physiotherapy, Sakakibara Heart Institute, Japan
13) Department of Rehabilitation, The Cardiovascular Institute, Japan
14) Department of Physical Therapy, School of Health Science, Tokyo University of Technology: 5-23-22 Nishikamada, Ohta-ku, Tokyo 144-8535, Japan

Abstract. [Purpose] This study aimed to elucidate characteristics of postoperative physical functional recovery in octogenarians undergoing coronary artery bypass graft surgery. [Subjects and Methods] This was a multi-center, retrospective study. Nine hundred and twenty-seven elective isolated coronary artery bypass graft surgeries were evaluated (746 males and 181 females, mean age: 68.6 years, range: 31–86 years). Participants were stratified according to age < 80 years (n = 840; mean age, 67.1; range, 31–79) or > 80 years (n = 87; mean age, 82.2; range, 80–86). Patient characteristics and postoperative physical functional recovery outcomes were compared between groups. [Results] There was no significant difference between groups when considering the postoperative day at which patients could sit on the edge of the bed, stand at bedside, or walk around the bed. The postoperative day at which patients could walk 100 m independently was later in octogenarians, when compared with non-octogenarians (6.1 ± 3.2 days vs. 4.9 ± 3.9 days). In octogenarians, the percentage of patients who could walk 100 m independently within 8 days after surgery was 79.5%. [Conclusion] A postoperative target time in octogenarians for independent walking, following coronary artery bypass grafting, can be set at approximately 6 days. 

Key words: Coronary artery bypass graft surgery, Octogenarian, Functional recovery

(This article was submitted Oct. 15, 2015, and was accepted Nov. 17, 2015)
INTRODUCTION

According to the Statistics Bureau, Ministry of Internal Affairs and Communications, the Japanese elderly population over 65 years old is estimated to number 33.8 million, accounting for 26.7% of the total population in 2015 [1]. Of these, octogenarians (aged 80 years and older) number about 10 million, and account for 7.9% of the total population [1]. As the population ages, the number of octogenarians undergoing cardiac surgery is increasing, as the safety of revascularization procedures for the elderly have made rapid progress, resulting from technical improvements in extracorporeal circulation (ECC) apparatuses, minimally invasive surgical procedures including off-pump coronary artery bypass grafting (OPCAB), and the development of post-surgical management. Numerous reports regarding cardiac surgery for octogenarians have focused on the performance of the surgery itself, graft patency rates, and life expectancy [2-7], and have generally been single-center studies [8]. In addition, reports on cardiac rehabilitation in octogenarians after cardiac surgery have mostly focused on the postoperative characteristics of patients with valvular heart disease involving aortic and mitral valves [9-12]. Moreover, there is very limited information regarding postoperative acute physical functional recovery after coronary artery bypass grafting (CABG), as most studies focusing on postoperative physical functional recovery have investigated cardiac rehabilitation in phase II (recovery phase) and phase III (maintenance phase) [13-16].

Therefore, the purpose of this study was to elucidate the characteristics of postoperative physical functional recovery of octogenarians undergoing CABG.

SUBJECTS AND METHODS

The present study was performed as a multicenter retrospective study. A total of 5,001 patients who underwent cardiovascular surgery, and were discharged alive, were identified from 12 institutes in Japan between January 2009 and March 2013. Of 5001 patients, 927 had had elective isolated CABG (including patients who underwent OPCAB). This group comprised 746 men and 181 women, with a mean age of 68.6 (31–86) years. This cohort was stratified according to age < 80 years (n = 840; mean age, 67.1; range, 31–79) or > 80 years (n = 87; mean age, 82.2; range, 80–86). Patient characteristics and postoperative physical functional recovery were compared between the two groups.

This study was a retrospective study examining patient medical records. The initiation of postoperative mobilization exercises, including getting out of bed (sitting on the edge of the bed), standing at bedside, and walking around the bed was examined. In addition, the postoperative day when patients walked 100 m independently was noted. 100 m of independent walking was defined as the point at which patients were able to walk more than 100 m in the hallway of the ward without supervision by health care workers, such as nurses or physical therapists. In principle, commencement of postoperative functional recovery program and criteria for assessing its progress were based on the guidelines established by the Japanese Circulation Society (JCS) [17]. JCS guidelines recommend achievement of a 100 m unassisted walk within 8 days postoperatively, at the latest. We also sought to identify the reason responsible in cases of unfavorable physical functional recovery, requiring more than 9 days for 100 m independent walking after surgery. These reasons were categorized according to cause; those resulting from heart failure and arrhythmia were considered heart-related reasons, those resulting from pneumonia and atelectasis as respiratory-related reasons, those resulting from cerebral infarction and decreased level of consciousness as central nervous system (CNS)-related reasons, those resulting from renal failure and dialysis treatment as renal-related reasons, and those resulting from low physical fitness as preoperative low abilities of daily living (ADL)-related reasons.

Two sample t-tests and χ² tests were performed to evaluate differences in preoperative, intraoperative, and postoperative clinical characteristics between groups. Data are expressed as mean ± standard deviation. Statistical analysis was performed using SPSS Statistics Version 22 (IBM, Tokyo, Japan), and the significance level was defined at p < 0.05 for all tests.

This is a retrospective observational study based on non-invasive assessment, for which approval from the Ethical Review Committee of Hyogo University of Health Sciences was obtained (No. 12029), in addition to the local institutional board at each participating hospital. All eligible patients were asked to provide informed consent at each institution.

RESULTS

There was no significant difference in the preoperative activities of daily living performance, as measured by the Barthel Index, preoperative ejection factor (%), preoperative brain natriuretic peptide (BNP) levels, preoperative lung function, operative time and anesthesia time between octogenarians and non-octogenarians (Table 1). Octogenarians were more commonly female (p < 0.05) and exhibited a higher volume of bleeding (p < 0.001), compared to non-octogenarians (Table 1). There was no significant difference in the postoperative day when patients sat on the edge of the bed, stood at bedside, or walked around the bed, between the groups (Table 1). The postoperative day that patients walked 100 m independently was longer in octogenarians, when compared with non-octogenarians (p < 0.05). The percentage of patients who could walk 100 m independently within 8 days after surgery was 79.5% in octogenarians and 92.0% in non-octogenarians. Fifteen patients (20.5%) from the octogenarian group and 56 (8.0%) patients in the non-octogenarian group required more than 9 days following surgery to walk 100 m independently. Both octogenarians and non-octogenarians exhibited a higher percentage of...
heart-related reasons responsible for unfavorable physical functional recovery following surgery. Preoperative lower ADL was also a primary cause in unfavorable physical functional recovery following surgery for both groups (Table 2).

**DISCUSSION**

Postoperative physical functional recovery, such as sitting on the edge of a bed, standing at bedside, and walking around the bed, showed no significant differences between younger patients and octogenarians. Furthermore, even in the octogenarians, 79.5% of patients could successfully walk 100 m independently within 8 days after surgery. In all 12 institutions with an active postoperative cardiac rehabilitation program, we found that octogenarians could begin postoperative ambulation at almost the same time as the younger patients.

Although octogenarians could begin postoperative ambulation equally early, the postoperative day on which patients walked independently was significantly later in octogenarians than in younger patients. This difference may have been influenced by a significantly greater amount of intraoperative blood loss in octogenarians. This would result in a decrease in blood hemoglobin and the number of red blood cells, and also an increase in the risk of low output syndrome (LOS), developing from a decrease in vascular capacity. Subsequently, this could extend the length of stay in the intensive care unit, possibly delaying postoperative functional recovery. This is consistent with previous findings, where the progress of postoperative cardiac rehabilitation programs was observed to be delayed in older patients, and those with large intraoperative blood losses\(^{18}\). Our results suggest that a target for the postoperative day at which octogenarian patients should be able to walk independently, following CABG, can be set at approximately 6 days after surgery.

According to a previous study, the main factors influencing unfavorable physical functional recovery after cardiac surgery were postoperative arrhythmias, particularly tachyarrhythmia including atrial fibrillation and atrial flutter, use of ECC apparatus including intra-aortic balloon pumping and percutaneous cardiopulmonary support, and prolonged cardiac arrest, such as...
as LOS\textsuperscript{19}). Our study concurred with these findings, with ‘heart-related reasons’ accounting for more than 40% of all reasons for unfavorable recovery, in both age groups. Thus, the percentage of ‘heart-related reasons’ did not show a significant difference between the groups, but rather preoperative physical deterioration categorized as ‘preoperative low abilities of daily living (ADL)-related reasons’ had a much higher incidence in octogenarians. This result suggests that preoperative physical function in octogenarians has a direct effect on postoperative physical functional recovery.

This study focused only on elective CABG via observation in acute physical functional recovery. Further studies are necessary to identify the characteristics of functional recovery following various other surgeries, including emergency surgery and complex surgery, and for elucidating the characteristics of functional recovery during phase II rehabilitation programs, in addition to long-term prognosis.

ACKNOWLEDGEMENTS

We thank the staff members of all hospitals, institutions, and universities in the cardiovascular surgery Physiotherapy Network, which collaborated in this study. This multicenter study was supported by Kitano Hospital, Sakakibara Heart Institute of Okayama, Higashi Takarazuka Satoh Hospital, Fukuyama Cardiovascular Hospital, Hyogo University of Health Sciences, Kasukabe Chuo General Hospital, Gunma Children’s Medical Center, Saiitama Medical University International Medical Center, Shizuoka Medical Center, Sakakibara Heart Institute, The Cardiovascular Institute, Tokyo University of Technology, and other CPN members.

REFERENCES

1) The Statistics Bureau of Japan: http://www.stat.go.jp/data/topics/topi901.htm (Accessed Oct. 1, 2015)
2) Nishino T, Saga T: Late result of coronary artery bypass grafting in 52 patients aged 80 year and older. J Jpn Coron Assoc, 2009, 15: 202–205.
3) Doi K, Yaku H: Coronary artery bypass grafting in octogenarians. J Jpn Coron Assoc, 2010, 16: 249–254.
4) Misumi H, Sasa T, Hirayama T: Strategy and results of coronary artery bypass grafting in octogenarians. J Jpn Coron Assoc, 2008, 14: 172–176.
5) Nishimi M, Tashiro T, Minematsu N, et al.: Status of off-pump CABG implemented in our institution, and issues for future consideration. J Jpn Coron Assoc, 2013, 20: 111–117. [CrossRef]
6) Takase S, Yokoyama H, Satokawa H, et al.: Short-term and long-term outcomes of octogenarians after off-pump coronary artery bypass surgery, 2010, 58: 561–567.
7) Graham MM, Ghali WA, Faris PD, et al. Alberta Provincial Project for Outcomes Assessment in Coronary Heart Disease (APPROACH) Investigators: Survival after coronary revascularization in the elderly. Circulation, 2002, 105: 2378–2384. [Medline] [CrossRef]
8) Munechika M, Shiraiishi H, Yamabata S, et al.: The program of cardiac rehabilitation after coronary artery bypass grafting. SHINZO, 2010, 43: 167–173.
9) Okamoto Y, Yamamoto K, Sugimoto T, et al.: Early and late outcomes of AVR with aortic annular enlargement in octogenarian. Gen Thorac Cardiovasc Surg, 2015, 63: 453–458. [Medline] [CrossRef]
10) Nakamura K, Nakamura E, Niina K, et al.: Outcome after valve surgery in octogenarians and efficacy of early mobilization with early cardiac rehabilitation. Gen Thorac Cardiovasc Surg, 2010, 58: 606–611. [Medline] [CrossRef]
11) Harris RS, Yan TD, Black D, et al.: Outcomes of surgical aortic valve replacement in octogenarians. Heart Lung Circ, 2013, 22: 618–626. [Medline] [CrossRef]
12) Furukawa H, Tanemoto K: Clinical efficacy of cardiac rehabilitation after coronary artery bypass grafting—Retrospective assessment of patients who did not received rehabilitation and further perspectives. J Jpn Coron Assoc, 2014, 20: 32–36. [CrossRef]
13) Lee CW, Wang JH, Hsieh JC, et al.: Effects of combined phase III and phase II cardiac exercise therapy for middle-aged male patients with acute myocardial infarction. J Phys Ther Sci, 2013, 25: 1415–1420. [Medline] [CrossRef]
14) Lee CW, Wang JH, Hsieh JC, et al.: Supervised phase II cardiac exercise therapy shortens the recovery of exercise capacity in patients with acute myocardial infarction. J Phys Ther Sci, 2014, 26: 1503–1508. [Medline] [CrossRef]
15) Lee Y, Jun I, Ju S: Impact of home exercise training on patients with acute myocardial infarction. J Phys Ther Sci, 2012, 24: 743–745. [CrossRef]
16) Lee Y, Lee J, Seo H, et al.: Effects of home-based exercise training with wireless monitoring on the left ventricular
function of acute coronary syndrome patients. J Phys Ther Sci, 2013, 25: 631–633. [Medline] [CrossRef]
17) Guidelines for Rehabilitation in Patients with Cardiovascular Disease: (JCS 2007) http://www.j-circ.or.jp/guideline/pdf/JCS2007_nohara_h.pdf (Accessed Oct. 1, 2015)
18) Takahashi T, Sakurada K, Kumamaru M, et al.: Multi-center analysis on rehabilitation progress standard after cardiovascular surgery. JJCR, 2012, 17: 103–109.
19) Kumamaru M, Takahashi T, Adachi J, et al.: Clinical characteristics associated with progress in cardiac rehabilitation after cardiovascular surgery. JJCR, 2012, 7: 109–112.