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Original Article

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

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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

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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 χ^2 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 Heath 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

Table 1. Comparison of clinical characteristics between octogenarians and non- octogenarians

	Octogenarians (n=87)	Non-octogenarians (n=840)
Age (years)	82.2 ± 2.3	67.1 ± 8.6**
Gender (male/female, n)	62/25	684/156*
Barthel Index	96.2 ± 14.3	96.7 ± 14.0
%VC (%)	86.9 ± 23.2	101.5 ± 69.1
FEV1.0% (%)	76.1 ± 8.7	81.7 ± 10.2
LVEF (%)	61.2 ± 12.5	59.9 ± 12.1
BNP (pg/ml)	293.5 ± 467.0	329.4 ± 1,229.9
Operative time (min)	284.1 ± 67.6	294.8 ± 79.4
Anesthesia time (min)	348.9 ± 67.6	294.8 ± 79.4
Volume of bleeding (ml)	946.7 ± 932.1	724.1 ± 660.9**
Postoperative day that patients sit (day)	1.9 ± 1.3	1.9 ± 2.2
Postoperative day that patients stood (day)	2.1 ± 1.4	2.1 ± 2.3
Postoperative day that patients walked (day)	3.1 ± 2.0	2.9 ± 3.8
Postoperative day that the patient walked 100 m independently (day)	6.1 ± 3.2	4.9 ± 3.9*

%VC: vital capacity percentage, FEV1.0: forced expiratory volume in 1 second, LVEF: left ventricular ejection fraction, BNP: brain natriuretic peptide
*p<0.05, **p<0.01

Table 2. Consideration of the reason for unfavorable functional recovery

	Octogenarians (n=15)	Non-octogenarians (n=56)
Heart-related reasons	6 (40%)	26 (46%)
Respiratory-related reasons	0 (0%)	3 (5%)
CNS-related reasons	0 (0%)	2 (4%)
Renal-related reasons	1 (7%)	5 (9%)
Wound-problems	0 (0%)	1 (2%)
Low ADL level -related reasons	5 (33%)	12 (21%)
Others	3 (20)	7 (13%)

CNS: central nervous system, ADL: abilities of daily living

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 LOS[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.

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