Impact of Early Ambulation on the Prognosis of Coronary Artery Bypass Grafting Patients

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Background: The effect of delayed ambulation on the outcome of coronary artery bypass grafting (CABG) remains to be clarified.

Methods and Results: The long-term and in-hospital outcomes of 887 patients who underwent isolated CABG (455 off-pump cases, 135 urgent cases) were evaluated, with a focus on the timing of first ambulation. Early ambulation (first ambulation within 3 days after operation) was achieved in 339 (38%) patients. In the multivariable logistic regression analysis, longer operation time and urgent case, EuroSCORE II, re-thoracotomy, and respiratory time were associated with delayed (≥4 days) ambulation. Delayed ambulation was associated with a high incidence of postoperative complications, such as pneumonia, and stroke (P<0.01). Following discharge, 22.2% of patients experienced major cardiac events and 13.8% died during the follow-up period (median follow-up 60 months). Cox hazards analysis revealed that delayed ambulation was associated with long-term adverse events (hazard ratio 1.04 per day, P<0.001). With adjustment for preoperative factors, the estimated future risk of adverse events was found to be increased day-by-day during the delay until initial ambulation.

Conclusions: In isolated CABG patients, delayed ambulation was associated with poor outcomes, even in the long-term period. The results support the current guideline recommending early ambulation protocol after cardiac surgery.

Key Words: Cardiac rehabilitation; Coronary artery bypass grafting; Exercise; Ischemia

More than 70,000 patients undergo cardiac surgery annually in Japan, and postoperative rehabilitation after coronary artery bypass grafting (CABG) can improve exercise tolerance, coronary risk factors, autonomic activity, cardiac function, and bypass patency. It has also been revealed that exercise therapy after cardiac surgery should be initiated as early as possible for recovery of the patient’s functional status, but postoperative complaints, such as pain, dizziness, nausea, vomiting, and fainting, often cause delayed ambulation after surgery. It has also been reported that age, level of physical activity, preoperative exercise tolerance, intraoperative blood loss, postoperative complications, and operative time are associated with delayed ambulation. Although there are some reports analyzing the factors associated with delayed ambulation, few have investigated the effect of postoperative early ambulation on outcomes.

We analyzed the factors associated with delayed ambulation in patients who underwent isolated CABG and to investigated the effect of postoperative early ambulation on late clinical outcomes.

Methods

Inclusion and Exclusion Criteria for Patients
Patients who underwent isolated CABG at Nagoya University Hospital between 2002 and 2018 were included in this study. In-hospital mortality cases (n=31) were excluded. After applying this exclusion criterion, 887 patients who underwent isolated CABG were evaluated retrospectively for their long-term and in-hospital outcomes based on medical records. This study was approved by the Institutional Review Board (IRB No. 2020-0060), which waived the requirement of individual consent. Here we report on...
experiments on human subjects in accordance with the ethical standards of the “Declaration of Helsinki” and the Committee in charge of human experimentation.

Definition of Outcomes, and Evaluation of Ambulation

Unless otherwise stated, the definitions of preoperative and postoperative outcomes were based on the Japan Adult Cardiovascular Surgery Database protocols. Composite preoperative risk was evaluated by EuroSCORE II. After the operation, ambulation was attempted with the guidance of professional physiotherapists based on current guidelines. Specifically, based on the standard progression of rehabilitation after cardiac surgery in the Guidelines for Rehabilitation in Cardiovascular Diseases (the joint guidelines of the Japanese Society of Cardiology and the Japanese Society of Cardiac Rehabilitation), we proceeded with the following on the first postoperative day: self-motion of limbs, passive sitting, breathing practice, as well as 10-minute sitting on the first and second postoperative days. Patients practiced sitting on the edge of the bed for 10 min and then standing foot stomping for 1–2 sets on the first and second postoperative days, with ambulation on the second and third postoperative days. The criteria for starting bed withdrawal were also based on the guidelines for bed withdrawal after cardiac surgery: surgery: (1) low output syndrome (LOS); (2) insertion of a Swan-Ganz catheter; (3) resting heart rate ≥120 beats/min; (4) unstable blood pressure (blood pressure falls only by changing positions); (5) unstable hemodynamics; and (6) unstable pulse. Weaning the patient from the bed was initiated if the above-mentioned criteria were satisfied, in the absence of the following conditions: (1) unstable hemodynamic arrhythmia; (2) dyspnea or tachypnea at rest (respiratory rate <30 breaths/min); and (3) continued postoperative bleeding tendency. Based on the guidelines, “early ambulation” was defined as first ambulation within 3 days after surgery (Group E) and delayed ambulation was defined as ambulation after 4 days (Group D).

After discharge, patients were followed in the outpatient clinic of Nagoya University Hospital or at an affiliated hospital/clinic on regular basis. For long-term outcomes, the primary endpoint was “cardiac event-free survival”. Cardiac events were defined as: heart failure, myocardial ischemic event (including myocardial infarction), or arrhythmic event requiring hospitalization.

Statistical Analysis

Continuous variables are expressed as the mean and standard deviation, and categorical variables are expressed as the number and percentage. Continuous variables were analyzed using the Mann-Whitney U-test, and categorical variables by Fisher’s exact test. Multivariable logistic regression analysis was performed to assess the factors associated with delayed initial ambulation. Kaplan-Meier curves were plotted, and the log-rank test was performed to compare the outcome for all-cause death and cardiac events in the 2 groups. In addition, we performed univariate and multivariable Cox regression analyses to estimate the hazard ratio (HR) of first ambulation for all-cause death and cardiac events. In the Cox regression analysis, EuroSCORE II, body mass index, and operation time were selected as known prognostic factors with reference to previous studies that described clinically necessary variables. Moreover, to visualize the estimated effect of each first ambulation day, we conducted a Cox regression analysis with spline functions for all-cause death, with adjustment for risk factors for cardiac events. Statistical analyses were performed using R version 3.55 (R Foundation for Statistical Computing, Vienna, Austria). In all analyses, two-tailed P values <0.05 were considered to indicate statistical significance.

Results

The baseline patient characteristics and in-hospital outcomes are summarized in Table 1. In the overall study population, the mean age was 68.6 ± 9.1 years and the mean EuroSCORE II was 3.6 ± 5.4. Early ambulation (first ambulation within 3 days of operation) was achieved in 339 (38.2%) patients (Group E). This cohort included 135 urgent
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non-elective surgery cases and 455 (51.3%) off-pump cases.

In comparison with Group E, the delayed ambulation patients (≥4 days) (Group D) showed a shorter 6-minute walk distance (6MWD: Group E 368.9 m vs. Group D 333.7 m, P=0.002), poor ejection fraction before operation (Group E vs. Group D: 60.7 vs. 56.8; P<0.001). Operation time was longer in Group D (Group E 5.6 h vs. Group D 6.1 h, P<0.001) but the percentage of off-pump CABG was similar between groups (Group E 49.0% vs. Group D 52.7%, P=0.3).

Not surprisingly, Group D showed a significantly higher incidence rate of postoperative complications, such as re-thoracotomy, pneumonia, and longer intubation (P<0.05). Baseline variables with P values <0.1 in the univariate analysis were included in the multivariable analysis. The multivariable logistic regression analysis identified longer operation time, urgent case, EuroSCORE II, re-thoracotomy, and respiratory time as factors associated with delayed initial ambulation (Table 2).

Following discharge, 22.2% of patients experienced major cardiac events (heart failure n=133, myocardial ischemic event n=56, arrhythmic event requiring intervention, n=8) and 13.8% of patients died during follow-up (median follow-up 60 months). Of the 122 deaths, the causes were cardiac death (n=32), cancer (n=29), pneumonia (n=19), stroke (n=12), other (n=12), and unknown (n=18). The incidence of such long-term events was significantly higher in Group D (Group E vs. Group D: 9.4% vs. 16.4%; P=0.004) (Table 3). Figure 1 showed the cumulative cardiac event-free survival rate. Group D exhibited worse long-term outcomes (P=0.044, log-rank).

Table 4 shows the results of the Cox regression analysis for late death and cardiac events. Delayed postoperative ambulation was significantly associated with late death.
By adjusting for preoperative factors, the estimated risk of future adverse events was found to increase day-by-day during the delay until initial ambulation. Similarly, Ishikawa et al. and Kono et al. conducted studies of patients hospitalized for acute heart failure. When the start of ambulation was delayed, cardiovascular events also increased in addition to prolongation of hospitalization and re-hospitalization. They pointed out that a decrease in skeletal muscle mass during hospitalization may be a cause of the problem.

Abdullahi et al. stated that low preoperative frailty and physical activity scores in open heart surgery patients were associated with increased early postoperative complications and prolonged hospital stay. Kamiya et al. showed that high quadriceps muscle strength after CABG was associated with cardiac-related death after hospital discharge. They reported that for every 10% increase of body weight in quadriceps muscle strength, the risk of cardiovascular death decreased by 34%. In the field of cardiac surgery, there may also be a relationship between loss of skeletal mass and a worse mid-term prognosis. The patients enrolled in that study were different from the patient population of...
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Conclusions

A longer operation time and urgent case, EuroSCORE II, re-thoracotomy, and respiratory time were associated with delayed (≥4 days) ambulation. In addition, in isolated CABG patients, delayed ambulation was associated with poor outcomes, even in the long-term period. The results support the current guideline recommending early ambulation following cardiac surgery.

Conflict of Interest Statement

The authors certify that no affiliation or financial involvement exists between them and any organization with a direct interest in the subject matter or materials discussed in the article.

Disclosures

The authors affirm that they have no financial or personal affiliations (including research funding) or other involvement with any commercial organization that has a direct financial interest in any matter included in this manuscript.

IRB Information

This study was approved by the Ethics Committee of Nagoya University Hospital (IRB No. 2020-0060).

Figure 2. Results of the Cox spline regression analysis. The estimated spline function in the hazard ratio on the effect of the day of first ambulation for all-cause death (A) and cardiac events (B). The hazard ratio (solid line) and 95% confidence interval (orange dashed lines) were estimated in a Cox multivariable model with the day to first ambulation represented as a spline function. Red dashed lines represent HR=1. CABG, coronary artery bypass grafting; CAG, coronary angiography; PCI, percutaneous coronary intervention; HF, heart failure.
References


Supplementary Files