Original Article

Early Tracheal Extubation after On-Pump Coronary Artery Bypass Grafting

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Objective: A fast-track recovery in cardiac surgery yields many benefits, and early tracheal extubation is important as the first step. The purpose of this study is to evaluate the status of early tracheal extubation after on-pump coronary artery bypass grafting (CABG) and to find key factors for successful early tracheal extubation.

Methods: From September 1996 to February 2005, isolated on-pump CABG was performed on 485 patients, and an early tracheal extubation protocol was employed on all. It was defined as tracheal extubation within 6 hr of arrival in the intensive care unit (ICU).

Results: An early tracheal extubation was successful on 450 patients (92.5%). Reintubation was necessary in 5 (1.1%) because of a resternotomy for bleeding in 3 and ventricular arrhythmia in 2. Mechanical ventilation exceeding 24 hours was required in 7 patients (1.4%) because of heart failure in 4 and respiratory failure in 3. Significant factors of successful early tracheal extubation were the European System for Cardiac Operative Risk Evaluation ($P < 0.05$), the number of diseased arteries ($P < 0.01$), ejection fraction ($P < 0.05$), operation time ($P < 0.01$), blood transfusion in ICU ($P < 0.05$), and drainage in the first 12 hr ($P < 0.05$).

Conclusions: Early tracheal extubation can be successfully performed in most patients receiving on-pump CABG. The management of higher-risk patients and efforts to reduce operation time and blood loss are keys to success for early tracheal extubation. (Ann Thorac Cardiovasc Surg 2009; 15: 239–242)

Key words: fast-track recovery, early tracheal extubation, on-pump coronary artery bypass grafting

Introduction

A fast-track recovery in cardiac surgery has demonstrated various benefits in clinical outcomes and in reducing medical costs. Early extubation plays a significant role in fast-track recovery. It has always been the goal of our program to perform on-pump coronary artery bypass grafting (CABG) with the expectation of an early tracheal extubation. Herein we describe our results and the key factors for a successful early tracheal extubation.

Subjects and Methods

From September 1996 to February 2005, a total of 670 on-pump CABG procedures were performed on patients at our institution, and 485 of them received elective isolated on-pump CABG. The mean age of patients was 68 ± 10 years, and 328 were males. Preoperative patient characteristics are listed in Table 1. The patients were divided into two groups by extubation time: extubation

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Table 1. Baseline characteristics of patients

Age in years (mean ± SD)	68 ± 10
Male:Female	328:157
BMI (mean ± SD)	23.4 ± 3.4
Comorbidities	
COPD	15 (3%)
Diabetes mellitus	182 (38%)
Hypertension	195 (40%)
Dialysis	20 (4%)
Peripheral vascular disease	27 (6%)
Cerebrovascular accident	86 (18%)
Current smoker	95 (20%)
EuroSCORE (mean ± SD)	4.0 ± 2.4
Coronary artery disease	
Number of diseased arteries (mean ± SD)	2.6 ± 0.6
CCS angina class (mean ± SD)	2.0 ± 0.7
History of MI	145 (30%)
MI within 2 weeks prior to CABG	48 (10%)
Unstable angina	108 (22%)
Left main stenosis	172 (35%)
Prior PCI	108 (22%)
Ejection fraction (mean ± SD)	61 ± 12%

SD, standard deviation; BMI, body mass index; COPD, chronic obstructive pulmonary disease; EuroSCORE, European System for Cardiac Operative Risk Evaluation; CCS, Canadian Cardiovascular Society; MI, myocardial infarction; CABG, coronary artery bypass grafting; PCI, percutaneous coronary artery intervention.

Table 2. Operative results

Number of bypass grafts (mean ± SD)	3.2 ± 1.0
CPB time (mean ± SD)	113 ± 35 min
Operation time (mean ± SD)	279 ± 65 min
Peak CK-MB (mean ± SD)	51 ± 39 IU
Hours intubated (mean ± SD)	206 ± 136 hr
Reintubation	5 (1.1%)
Mechanical ventilation > 24 hr	7 (1.4%)
No blood transfusion	306 (63%)
Amount of drainage in 12 hr (mean ± SD)	269 ± 217 ml
Operative death	2 (0.4%)

SD, standard deviation; CPB, cardiopulmonary bypass; CK-MB, creatine kinase MB isoenzyme.

< 6 hr (group A) and extubation ≥ 6 hr (group B). A comparison of the two groups was made to find the factors related to early tracheal extubation.

Anesthetic and surgical procedures

The early tracheal extubation protocol used the following procedures. The fentanyl dosage was from 200 to 500 μg with inhalation anesthetic agents. Midazolam 0.1 mg/kg was used early in the series as a sedative agent, but it was replaced with propofol 2 mg/kg/h. After we harvested the bypass graft conduits, a cardiopulmonary bypass (CPB) was established using an inflow cannula placed in the right atrium and an outflow cannula in the ascending aorta while body temperature was maintained at 34°C. Epiaortic echography was performed on all patients to avoid any risk of emboli. All CPB circuits were coated with heparin, and a centrifugal pump was used. The priming volume for the CPB circuit was less than 1,000 ml. Aprotinin, 500,000 units drip infusion from a central venous line before skin incision and 500,000 units for CPB priming, was used to reduce bleeding. A jet ventilator (AS-25, Mera, Senko Medical Instrument Mfg. Co., Ltd., Tokyo, Japan) was connected to the patient being supported with CPB. It had an FiO_2 setting of 65%, a working pressure of 1 ps and 10 Hz, and an inspiratory-to-expiratory (I/E) ratio of 10%. Intermittent antegrade cold hyperkalemic blood cardioplegia with terminal warm blood cardioplegia was used. The patients were weaned from CPB while receiving continuous infusions of dopamine, dobutamine, and isosorbide.

Postoperative management

For this study, early tracheal extubation was defined as tracheal extubation within 6 hours of arrival at the ICU. All patients were warmed with forced air until the surface temperature reached 36°C. The criteria for tracheal extubation were a conscious patient in hemodynamically stable condition and having an arterial oxygen content > 70 mmHg at FiO_2 of 50%.

Statistical methods

The data were expressed as mean ± standard deviation. All analyses were conducted using StatView 5.0 software (SAS Institute Inc., Cary, NC, USA) to identify the relating factors of successful early tracheal extubation, and a P value of 0.05 or less was considered significant.

Results

The results are shown in Table 2. The number of distal anastomoses was 3.2 ± 1.0, and the operative time was 279 ± 65 min. A blood transfusion was avoided in 306 patients (63%). Because of the epiaortic echography findings, the ascending aorta was not clamped in 7 out of the 485 patients receiving on-pump CABG. Early tracheal extubation was successful in 450 patients (92.8%). Reintubation was necessary in 5 (1.1%) because of reoperation

Table 3. Comparison of factors between groups A and B

	Group A	Group B	P value
Age in years (mean ± SD)	67.9 ± 9.6	70.6 ± 8.0	0.11
Female	32%	38%	0.56
BMI (mean ± SD)	23.4 ± 3.0	23.7 ± 3.3	0.70
COPD	2.8%	3.4%	0.88
Cerebrovascular accident	18%	17%	0.94
Preoperative creatine level (mean ± SD) (mg/dl)	1.0 ± 1.2	1.5 ± 1.6	0.13
EuroSCORE (mean ± SD)	3.9 ± 2.4	4.8 ± 2.4	<0.05
Number of diseased arteries (mean ± SD)	2.6 ± 0.6	2.9 ± 0.4	<0.01
Ejection fraction (mean ± SD) (%)	60.9 ± 11.9	56.4 ± 11.0	<0.05
Transfusion in operation room	22%	28%	0.39
Number of bypass grafts	3.2 ± 1.0	3.5 ± 1.0	0.16
Operation time (mean ± SD) (min)	275 ± 62	325 ± 83	<0.01
CPB time (mean ± SD) (min)	111 ± 34	140 ± 36	<0.01
Clamp time (mean ± SD) (min)	77 ± 26	99 ± 26	<0.01
Peak CK-MB (mean ± SD) (IU)	49 ± 37	70 ± 58	0.07
Transfusion in ICU	23%	45%	<0.05
Drainage in first 12 hr (mean ± SD) (ml)	260 ± 202	359 ± 216	<0.05

SD, standard deviation; BMI, body mass index; COPD, chronic obstructive pulmonary disease; EuroSCORE, European System for Cardiac Operative Risk Evaluation; CPB, cardiopulmonary bypass; CK-MB, creatine kinase MB isoenzyme; ICU, intensive care unit.

for bleeding in 3 and ventricular tachycardia in 2. Mechanical ventilation exceeding 24 hr was required in 7 patients (1.4%) because of heart failure in 4 and respiratory failure in 3. Operative death occurred in 2 patients (0.4%). Comparisons were made between group A (extubation < 6 hr, n = 450) and group B (extubation ≥ 6 hr, n = 29). Significant factors of early tracheal extubation were the European System for Cardiac Operative Risk Evaluation (EuroSCORE) (P <0.05), number of diseased arteries (P <0.01), ejection fraction (EF) (P <0.05), operation time (P <0.01), blood transfusion in ICU (P <0.05), and drainage in the first 12 hr (P <0.05) (Table 3). High-risk patients represented as higher EuroSCORE and multiple coronary artery disease, and poor EF appeared to be intubated a longer time postoperatively. A longer operation time, including CPB time and clamp time, made postoperative intubation time longer. Postoperative bleeding volume and blood transfusion were significantly related to the early extubation.

Discussion

A fast-track recovery in cardiac surgery has been reported to produce many benefits.[1–7] Early tracheal extubation is the most important step in the fast-track recovery process, and its potential benefits are decreased morbidity and medical costs. We have employed a fast-track recovery protocol since 1996 at our institution during the same period that Cheng et al. reported the safety and efficacy of early extubation in their prospective randomized clinical study.[1] Reis et al. also demonstrated that early extubation does not increase complication rates after CABG in patients supported by CPB.[2] We believe that the key elements to successful early tracheal extubation are the use of minimal dosages of fentanyl in conjunction with inhalation anesthetic agents; the employment of jet ventilation while the patient is supported by CPB; and a reduced blood transfusion. The total dosage of fentanyl was decreased to 200 μg without causing complications. The potential advantages of inhalation anesthetic agents in patients receiving CABG have been demonstrated.[8] These agents have been shown to have cardioprotective effects, such as preconditioning properties and protection against reperfusion injury. Utilizing jet ventilation during CPB prevents alveoli collapse, which is advantageous to facilitating respiratory recovery. The effectiveness of jet ventilation was reported in thoracic surgery; however, it was not proven in cardiac surgery.[9] Unfortunately we have no data available to demonstrate the effectiveness of jet ventilation during CPB, since we had applied jet ventilation from the beginning of our study. Légaré et al. analyzed preoperative and intraoperative variables predictive to prolonged mechanical ventilation (≥ 24 hr) in 1,829

CABG patients.[3] They found the following factors to be predictors of prolonged ventilation: unstable angina, EF <50, chronic obstructive pulmonary disease (COPD), renal failure, female gender, age > 70 years, perioperative stroke, reoperation for bleeding, and perioperative myocardial infarction (MI). From our study, EF and postoperative bleeding are compatible to their findings. Guller et al. revealed that certain subsets such as females, age > 70 years, COPD, and recent MI were significantly less likely to undergo early extubation (< 6 hr) in their 6,446 CABG patients.[4] Alhan et al. demonstrated that predictors of delayed extubation (≥ 6 hr) are any red blood cell transfusion and cross-clamp time > 60 min in their high-risk (EuroSCORE ≥6, n = 158) CABG patients.[5] We totally agree with their results, and our efforts to minimize blood transfusion include the use of aprotinin, reduction of the CPB circuit priming volume, and suppression of the inflammatory response with the use of a heparin-coated CPB circuit. Øvrum et al. demonstrated that early tracheal extubation within 5 hr of ICU arrival was successfully performed in more than 99% of 5,658 CABG patients.[6] In that study, 65 patients (1.1%) were reintubated because of resternotomies for bleeding or cardiopulmonary decompression. For the most part, our protocol and concept are similar to these studies, and our study's reintubation rate, cause, and operative mortality were also quite similar. In a large sample, Guller et al. evaluated risk factors for reintubation, which were prolonged intubation time, older age, elevated blood urea nitrogen, MI on the day of CABG, history of COPD, presence of peripheral arterial disease, presence of mitral insufficiency, low EF, current smoking status, and emergency operation. However, they found no evidence that early extubation was harmful.[4] Ott et al. showed that rapid recovery, including early extubation, after CABG was possible even in elderly patients (> 70 years).[7] Our results showed that age was not a predictor for early tracheal extubation, thus supporting their results.

Conclusion

Early tracheal extubation can be successfully performed in patients receiving on-pump CABG. The management of higher-risk patients and efforts to reduce operation time and blood loss are keys to success for early tracheal extubation.

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