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Early Extubation and Fast-Track Anesthetic Technique for Endoscopic Cardiac Surgery

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ABSTRACT

Objective: In this retrospective study, we evaluated the "fast-track" recovery protocol for endoscopic Port Access™ (PA) (Edwards Lifesciences) heart procedures. We also determined which factors and variables are important for the success of immediate extubation at the end of the operation while the patient is still in the operating room (OR).

Methods: In the study, we included 104 patients scheduled for PA heart surgery under cardioplegic arrest. All patients were marked before surgery for the fast-track recovery protocol. If the patients fulfilled the extubation criteria within 10 to 15 minutes after the end of operation, they were extubated in the OR (OR group); the others were transferred to the intensive care unit (ICU) (ICU group) and extubated later. The 2 groups were compared with respect to preoperative and intraoperative variables that could influence early extubation, postoperative complications, duration of ICU stay, and hospital stay.

Results: Seventy-eight patients (75%) were extubated in the OR. The patients from the OR group had significantly lower EuroSCOREs than the patients from the ICU group (P = .025). The variables of vital capacity (P = .001) and forced expiratory volume in the first second (FEV_1) (P < .001) were significantly higher preoperatively in the OR group than in the ICU group. There were no significant differences between the groups with respect to intraoperative characteristics. Postoperative complications were fewer in the OR group. The mean duration of ICU stay was significantly shorter in the OR group than in the ICU group (P < .001).

Conclusions: Immediate extubation in the OR after endoscopic cardiac procedures is safe and possible for the majority of patients. The preoperative patient characteristics of EuroSCORE, vital capacity, and FEV_1 influence the success of ontable extubation.

INTRODUCTION

At the end of the 1990s, there was a rapid expansion of a "fast-track" protocol for postoperative recovery in cardiac surgery [Wilmore 2002]. The development and introduction of this protocol demand a multidisciplinary approach by surgeons, anesthesiologists, and intensive care clinicians [Cheng 1998a]. The goal is to lessen the physical and psychological stress of the patient to the surgery, avoid postoperative complications, and achieve faster rehabilitation [Kehlet 2005]. One of the key points of this protocol is early extubation.

Endoscopic cardiac surgery with the Port Access™ (PA) system (Edwards Lifesciences, Irvine, CA, USA) and video technology is one of the less-invasive cardiac procedures [Gersak 2005; Antonic 2007]. Because the surgical wound is smaller and the tissue injury is less, there is less of a stress response by the patient to the surgery [Glower 1998]. This new surgical technique requires the modification of the anesthesiologic approach and provides the opportunity to develop a fast-track protocol for postoperative recovery.

PATIENTS AND METHODS

Patients and Procedures

In our retrospective study, we included 104 patients who underwent an endoscopic cardiac procedure over a 2-year period. These patients underwent operations for mitral or tricuspid valve dysfunction, cardiac tumor removal, or atrial septal defect repair. Prior to surgery, all of the patients were marked for the fast-track recovery protocol, with the intent of extubating the patient in the operating room (OR) within 10 to 15 minutes after the last skin suture was made. The patients were divided into 2 groups: patients who were extubated in the OR (OR group) and patients who were extubated in the intensive care unit (ICU) (ICU group). The OR and ICU groups were compared with respect to pre- and intraoperative variables that could influence early extubation. The preoperative variables that could influence the success of early extubation were age, sex, New York Heart Association (NYHA) classification, left ventricular function, EuroSCORE (European System for Cardiac Operative Risk Evaluation), lung function, and pulmonary hypertension. The intraoperative variables that also could influence early extubation were cardiopulmonary bypass (CPB) time, aorta cross-clamp time, and the need for high inotropic support at the end of the operation. To evaluate the risk of early extubation, we compared postoperative complications in the 2 groups. Postoperative complications that we took into consideration were respiratory, central nervous, renal, and cardiovascular systems. We also compared the groups with respect to the mortality rate and the durations of stay in the ICU and the hospital.

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Table 1. Criteria for Extubation in the Operating Room*

Criteria	Suitability for Extubation
Hemodynamics	MAP, 50-80 mm Hg; heart rate, 50-90 beats/min; dobutamine <5 μg/kg; no sign of myocardial ischemia†
Ventilation	Spontaneous breathing; respiratory rate, 10-18/min; TV, ≥8 mL/kg
Consciousness	Obey simple commands
Muscular strength	Lift the head and hold for 30 s
Body temperature	37.0°C < 36.0°C
VAS	<3

*MAP indicates mean arterial pressure; TV, tidal volume; VAS, visual analogue scale.

†Sign of myocardial ischemia: change in S-T segment.

Table 2. Demographic Data and Procedure Type*

	OR Group (n = 78)	ICU Group (n = 26)	*P*
Age, y†	59.6 ± 12.2	64.8 ± 11.7	.054
Male/female sex, n	33/45 (42%/58%)	9/17 (35%/65%)	.489
MVR/PMV, n	43 (55%)	17 (65%)	.55
MVR/PMV and PTV, n	29 (37%)	7 (26%)	.441
Other, n	6 (7%)	2 (7%)	1

*OR indicates operating room; ICU, intensive care unit; MVR, mitral valve replacement; PMV, plastic mitral valve; PTV, plastic tricuspid valve.

†Data are presented as the mean ± SD.

Surgical Protocol

The operation was performed through a thoracotomy of 2.5 cm to 3 cm in length in the third or fourth intercostal space on the right side of thorax; therefore, the right side of the lungs was not inflated during the operation. To establish CPB, we used the standard cannulas for the PA technique and antegrade cold blood cardioplegia for heart protection. Heparin (300 IU/kg) was administered for anticoagulation when the cannulas were inserted. The patients were cooled to 29°C during CPB and were rewarmed to 37°C before discontinuation of CPB.

Anesthetic Protocol

The patients were admitted to the hospital a day before the planned operation. On the day of the procedure, patients were premedicated with 5 mg flurazepam. During the operation, short-term anesthetics and opioid analgesics were used. General anesthesia was started with fentanyl (3-5 μg/kg), etomidate (0.3 mg/kg), and the muscle relaxant vecuronium (0.1 mg/kg). Ventilation of only 1 lung during the procedure was achieved by intubating the patients with a double-lumen tube. For maintaining anesthesia, a continuous infusion of the ultrashort-acting opioid remifentanyl (0.2-0.3 μg/kg per minute) and sevoflurane (1.0%-1.2%) with a 1:1 oxygen-air mixture was used; during CPB, continuous infusion of propofol (3-4 mg/kg per hour) was used instead of sevoflurane. If the patients fulfilled the extubation criteria within 15 minutes after the last skin suture was made, they were extubated on the operating table. Otherwise, the intubated patient was transferred to the ICU and extubated later. Extubation criteria are summarized in Table 1.

Patient Monitoring

Standard procedures for hemodynamic monitoring for PA cardiac surgery were used and included a 5-lead electrocardiogram, pulse oximetry, invasive blood pressure measurement in both the left and right radial arteries, and monitoring of the central venous pressure. Swan-Ganz catheterization was performed in the event of pulmonary hypertension. Transesophageal echocardiography was used with all patients.

Postoperative Analgesia

Before closing of the surgical wound, a multihole epidural catheter was placed between the muscles beside the wound in the vicinity of the intercostal nerve. At the end of the procedure, a bolus of local anesthetic (10 mL of 0.75% ropivacaine or 10 mL of 0.5% bupivacaine) was applied through the catheter. All other wounds on the thorax and in the groin for catheters, cannulas, and draining were also infiltrated with 10 mL of local anesthetic. A continuous infusion of 5 mL/h of 0.15% ropivacaine or 0.15% bupivacaine was started through the catheter when the patient was admitted to the ICU. In the ICU, the analgesic was supplemented with 1.25 g metamizole on a regular basis.

Statistical Analyses

Parametric data were statistically analyzed with the unpaired Student *t* test; the χ^2 test was used to compare dichotomous data. A *P* value <.05 was considered to indicate statistical significance. Results are expressed as the mean ± SD or as percentages.

RESULTS

Of the 104 patients included in the study, we managed to extubate 78 patients (75%) in the OR. Demographic data and the procedures used are summarized in Table 2.

One patient was not extubated because she died. Three patients were determined not to be extubated before or during the procedures, because of difficulties with the intubation in 1 patient, dissection of the aorta during the operation in 1 patient, and a severe allergic reaction in the third patient. Thirteen (50%) of the patients in the ICU group were extubated within 4 hours after admission to the ICU.

Two patients (1.9%) from the OR group had to be reintubated in the first 24 hours, 1 because of reoperation for excessive bleeding and the other because of mental disturbance due to cerebrovascular ischemia. No patient needed to be reintubated for respiratory insufficiency. The preoperative characteristics of the patients are summarized in Table 3. The mean

Table 3. Preoperative Characteristics of the Patients*

	OR Group (n = 78)	ICU Group (n = 26)	*P*
NYHA class 3 or 4, n	43 (55%)	19 (73%)	.106
Pulmonary hypertension, n	55 (79%)	20 (80%)	.881
LV ejection fraction, %	58.6 ± 10.5	57.2 ± 8.7	.518
EuroSCORE	4.71 ± 16.2	6 ± 2.8	.025
Vital capacity, %	98.1 ± 16.2	80.3 ± 20.2	<.001
FEV1, %	91.7 ± 19.2	69.8 ± 24.3	.001

*Data are presented as the mean ± SD where indicated. OR indicates operating room; ICU, intensive care unit; NYHA, New York Heart Association; LV, left ventricle; FEV1, forced expiratory volume in the first second.

Table 4. Intraoperative Variables*

	OR Group (n = 78)	ICU Group (n = 26)	*P*
CPB time, min	142 ± 38	147 ± 47.2	.625
Cross-clamp time, min	83.3 ± 23.1	82.2 ± 30	.862
Dobutamine, μg/kg per min	1.19 ± 1.89	1.52 ± 2.29	.571

*Data are presented as the mean ± SD. OR indicates operating room; ICU, intensive care unit; CPB, cardiopulmonary bypass.

Table 5. Postoperative Increases in Enzymes*

	OR Group (n = 78)	ICU Group (n = 26)	*P*
CK, μckat/L	23.6 ± 81.9	38 ± 65.1	.494
LDH, μckat/L	10.1 ± 17.3	22.9 ± 67.9	.257
ICU stay, h	36 ± 41.7	75.5 ± 92.8	<.001
Hospital stay, d	10.4 ± 2.7	11.2 ± 3.7	.146

*Data are presented as the mean ± SD. OR indicates operating room; ICU, intensive care unit; CK, creatine kinase; LDH, lactate dehydrogenase.

Table 6. Postoperative Complications*

	OR Group (n = 78)	ICU Group (n = 26)
CVS, n	9 (11%)	8 (30%)
Kidneys, n	0	1 (3%)
Respiratory system, n	0	1 (3%)
CNS, n	2 (2%)	4 (15%)
Mortality, n	1 (1%)	2 (7%)
All complications, n	12 (15%)	16 (61%)†

*OR indicates operating room; ICU, intensive care unit; CVS, cardiovascular system; CNS, central nervous system.

†*P* < .001.

preoperative values for vital capacity (*P* < .001) and forced expiratory volume in the first second (FEV_1) (*P* = .001) were significantly higher in the OR group than in the ICU group. The 2 groups also differed with respect to the EuroSCORE.

Intraoperative variables that did not influence early extubation are summarized in Table 4.

The 2 groups did not differ with respect to postoperative increases in enzymes (creatine kinase and lactate dehydrogenase) (Table 5). ICU stays were much shorter in the OR group (mean ± SD, 36 ± 41.7 hours) than in the ICU group (75.5 ± 92.8 hours), but hospital stays in the OR group (10.4 ± 2.7 days) were not significantly shorter than in the ICU group (11.2 ± 3.7 days) (Table 5).

The total postoperative complications, including mortality and those involving the respiratory, central nervous, cardiovascular, and renal systems, were significantly fewer in the OR group (*P* < .001; Table 6).

DISCUSSION

In our study, we have proved that on-table extubation after endoscopic cardiac surgery for mitral and tricuspid valves is possible and safe. To our knowledge, all studies to date that have described early extubation and a fast-track protocol involved patients who underwent their operations with a standard surgical technique via median sternotomy [Royse 1999; Marianeschi 2000; Vircella 2000; Alhan 2003]. In all of these studies, early extubation was considered extubation on the operating table or within 6 hours after the end of the operation, and the success rate for early extubation thus defined was between 85% and 100% [Royse 1999; Marianeschi 2000; Vircella 2000].

From this point of view, the percentage (75%) of patients that we managed to extubate would appear to be low. One of the reasons for this lower success rate compared with other studies could be that all of the patients included in our study underwent their operations with CPB under hypothermic conditions and were not preselected. Also important to point out is the fact that there were no coronary artery bypass grafting patients in our study. Therefore, all comparisons with other studies should take these differences into account. The highest reported success rates for early extubation (between 95% and 100%) are for off-pump coronary artery bypass grafting [Djaiani 2001; Straka 2002]; however, for patients who underwent coronary artery operations with CPB, the reported rate of early extubation is 92% [Oxelbark 2001]. The extubation rates for patients who underwent their operations with CPB under hypothermia and thus could be compared with our group are between 60% and 85% [Bando 1997; Royse 1999]. Hypothermia and shivering especially make early extubation more difficult. Because of the low body temperature, we did not extubate 2 patients. We also did not exclude in advance patients with such comorbidities as obesity, chronic obstructive pulmonary disease, and advanced age, which could increase the failure rate for early extubation [Cheng 1999; Wong 1999]. For that reason, we also did not analyze these variables. Four patients were not extubated because of transient psychomotor disturbances, which were the side effects of the CPB.

Considering the group of patients extubated in the OR and the group extubated during the first 4 hours in the ICU, the success rate of early extubation in our study is 87.5%. That value is close to the results that have been reported for other studies [Royse 1999; Djaiani 2001; Oxelbark 2001; Straka 2002].

Anesthesiologists often hesitate to extubate patients on the operating table immediately after the end of the procedure because of the fear that reintubation might be needed in the early postoperative period, when the potential for hemodynamic instability is highest. Respiratory distress and low oxygen saturation could additionally jeopardize such patients [Rady 1999]. The frequency of the need for early reintubation within 24 hours after extubation has been reported to be between 2% and 6.6% [Cheng 1996; Plümer 1998; Wong 1999].

In our study, 2 patients required early reintubation, one because of reoperation for excessive bleeding and the other because of mental disturbance due to cerebrovascular ischemia. No patient required reintubation for respiratory insufficiency.

Another conclusion of our study was that preoperative characteristics and other variables are important for the success of on-table extubation. Three preoperative characteristics are important: vital capacity, FEV_1, and EuroSCORE. A patient with a vital capacity <80%, a FEV_1 value <70%, and a EuroSCORE >5 has a decreased probability for successful on-table extubation. In addition, the conclusion of other studies is that patients' preoperative characteristics determine the success of early extubation [Bando 1997; Plümer 1998; Alhan 2003].

Contrary to our expectation, intraoperative variables (CPB time, aorta cross-clamp time, and a need for high inotropic support at the end of the operation) had no influence on the success of early extubation; however, events occurring during the operation could delay extubation. In our group of patients, such events were severe allergic reaction, dissection of the aorta, and difficult intubation.

We also have proved that early extubation is safe for patients. The group of patients who were extubated in the OR had fewer postoperative complications.

In all studies of early extubation and fast-track recovery, the investigators were especially interested in whether the risk for postoperative complications was increased in connection with early extubation [Higgins 1992; Cheng 1996; Chen 1998; Cheng 1998a; Cheng 2005]. It has been advocated that early extubation be applied only to selected patients and that high-risk patients also be excluded from the fast-track protocol. Recently, however, many studies have proved that early extubation is safe for high-risk patients [Plümer 1998; Alhan 2003].

One of the goals of early extubation is to shorten ICU and hospitalization stays. In our study, the patients in the OR group stayed in the ICU for a shorter time. The mean ICU stay was 36 hours for the OR group and 75.9 hours for the ICU group. Most of the patients were admitted to the ICU in late afternoon or early evening, and they usually stayed in the ICU for 2 nights, because we do not transfer such patients to the ward in the afternoon. That is why 36 hours seems quite long.

Shortening the time in the ICU is important not only to reduce expenses [Cheng 1998a, 1998b] but also to minimize hospital infections [Vincent 1995] and to achieve a faster physical and psychological rehabilitation [Chong 1992].

Our desire was to transfer patients to the ward on the first or the second postoperative day, but not before the transfer criteria were fulfilled. These criteria are hemodynamic stability without inotropic support, absence of cardiac arrhythmias, removal of the thoracic drain, and capability of the patient for everyday activities.

In our study, the 2 groups did not differ with respect to the time of hospitalization. The reason for the lack of difference could be that the criteria for discharge from the hospital are not as clearly defined; hospital discharge also depends on the social conditions.

Although postoperative analgesia was not a topic for this report, it is worth mentioning that good postoperative analgesia is of crucial importance for early extubation and the success of the fast-track protocol. Instead of classic high-dose opioid postoperative analgesia, we administered local anesthetic for the incision through the catheter in the surgical wound. This technique has already been successfully applied in other surgical fields [Vintar 2002], and we also found this technique to be suitable for PA surgery [Sostaric 2005]. In this way, we provide satisfactory postoperative analgesia and avoid the unwanted side effects of opioids.

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