Off-Pump Coronary Artery Bypass Surgery : Evaluation of Extubation Time and Predictors of Failed Early Extubation

PRANOM CUMPEERAVUT, MD*, KITIPAN VISUDHAROM, MD*,
VIBUL JOTISAKULRATANA, MD*, VITOON PITIGUAGOOL, MD*,
SUJIT BANYATPIYAPHOD, MD*, PIYAPAN PAMORNSING, MD*

Abstract

Anesthesia during and after off-pump surgery is critical for the outcome of the procedure. Intubation time has been shown to correlate with ICU time and length of stay. This study is to evaluate the extubation time and predictors of prolonged extubation in this institution.

One hundred and sixty consecutive patients during Jan 2001 - June 2002, excluding pre-operative tracheostomy (n = 1) were retrospectively reviewed. Anesthetic agents include fentanyl, rocuronium Bromide, midazolam and sevoflurane. Phenylephrine and nitroglycerine were used to maintain adequate arterial pressures. Post-operative pain control was mainly with intravenous fentanyl and oral pain medications.

The extubation time was divided into 4 groups; 0-2 h, n = 76, mean =1.11 $\pm$ 0.5 h; 2-4 h, n = 30, mean = 2.91 $\pm$ 0.5 h; 4-24 h, n = 39, mean = 11.44 $\pm$ 7.3 h; > 24 h, n = 5, mean = 33.3 $\pm$ 21 h.

The data were collected and analyzed following the guidelines of National STS cardiac surgery database. All pre-operative risk factors included: Age (> 70 yrs *vs* $\leq$ 70 yrs), gender (male *vs* female), diabetes (yes *vs* no), hypertension (yes *vs* no), morbid obesity (yes *vs* no), renal insufficiency (yes *vs* no), chronic obstructive lung disease (yes *vs* no), history of cerebrovascular accident (yes *vs* no), smoking (yes *vs* no), dyslipidemia (yes *vs* no), history of myocardial infarction (MI) (yes *vs* no), history of congestive heart failure (CHF) (yes *vs* no), unstable angina (yes *vs* no), left ventricular ejection fraction (LVEF) (> 40% *vs* $\leq$ 40%), left main (LM) lesion (LM > 50% *vs* LM $\leq$ 50%), intra-aortic balloon pump (IABP) used (yes *vs* no) and time between operating and closing (> 4.30 h *vs* $\leq$ 4.30 h) were used to predict failed early extubation (2 h)

More than 50 per cent of the patients were extubated in less than 2 h. (1.11 $\pm$ 0.5 h) and only 5 patients were extubated after 24 h. Univariate analysis revealed old age, diabetes, MI, CHF, LVEF $\leq$ 0.4 and the use of IABP are the predictors ($p < 0.05$) of failed early extubation. Multivariate analysis of these variables revealed old age with adjusted odds ratio of 4.6 (95% CI = 1.5-13.7) $p < 0.01$,

diabetes with adjusted odds ratio of 3.2 (95% CI = 1.3-7.5) $p < 0.01$ and IABP used with adjusted odds ratio of 4.3 (95% CI = 1.3-14.6) $p = 0.02$ are the predictors of fail early extubation. The findings suggested early extubation is possible in OPCAB surgery and attention should be made when operate in patients who have old age, diabetes, and IABP used.

Key word : Early Extubation in OPCAB

CUMPEERAVUT P, VISUDHAROM K, JOTISAKULRATANA V, PITIGUAGOOL V, BANYATPIYAPHOD S, PAMORNSING P
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* Bangkok Heart Institute, Bangkok Hospital, Bangkok 10320, Thailand.

Off-Pump coronary artery bypass surgery or "OPCAB" is being utilized more and more at the Bangkok Heart Institute. This program was started slowly in January of 2001 with very few cases scheduled along with the conventional "On-pump" procedure. During this initial period, teaching and learning experiences allowed the authors to become more familiar with the procedure and the potential complications from verticalizing the heart. One of the primary goals for anesthesiologists is to maintain stable hemodynamics during the critical episodes and to help the surgeons perform the surgery at ease. At the same time an attempt is made to extubate the patients as early as possible. In order to find out what has been accomplished so far, the authors decided to review the past 18 months' experience with OPCAB and extubation time.

MATERIAL AND METHOD

The medical records of all OPCAB patients performed at the Bangkok Heart Institute from Jan 1, 2001 through June 30, 2002 were retrospectively reviewed. These data were collected daily using the National Cardiac Surgery Database definition/variables and collecting forms and analyzed using SPSS software. Patients who had had tracheostomy done prior to the operation were excluded from this study. The total number of patients was 160.

Definitions

Early extubation is defined as extubation that occurred within 2 hours after operation. Failed early extubation is defined as extubation over 2 hours after operation or reintubation within 24 hours.

Study parameters

Pre-operative demographic, intra-operative data and post-operative outcome parameters are listed in Table 1.

Statistical analysis

Chi-square test was used to compare clinical variables between patients with early extubation and patients with failed early extubation. All statistical tests were two tailed, with statistical significance defined as $p < 0.05$.

The influence of variables on early extubation was analyzed using the logistic regression for multivariate analysis. A p-value of less than 0.05 was considered significant.

Anesthetic technique

All patients received midazolam 7.5-15 mg orally 30 minutes prior to operation. On arrival in the operating room, patients were monitored using electrocardiography lead II and V, noninvasive blood pressure, pulse oxymeter, end tidal carbondioxide, nasal/rectal temperature, central venous pressure, pulmonary arterial pressure, Wedge pressure, mean arterial pressure and nerve stimulator. All patients received the same anesthetic regimens: induction and maintenance with intravenous midazolam at a total dose of 5 mg and intravenous fentanyl at a total dose of 3-10 mcg/kg, paralyzed with intravenous rocuronium bro-

mide 1-2 mg/kg and supplemented with sevoflurane. During operation, blood pressure was controlled with a titrate dose of phenylephrine and nitroglycerine. Heart rate was controlled with esmolol.

Post-operative care

During the post-operative period, all patients were admitted to the intensive care unit and put on Servo300 ventilatory support. Post-operative pain control regimens were intravenous fentanyl 50-100 mcg every 1 hour and intravenous morphine 0.1 mg/kg every 2-3 hours. Evaluation of extubation was done by an anesthesiologist using standard criteria for weaning and extubation[1]. After extubation, all patients were on a 100 per cent oxygen face mask and weaned to oxygen canular as tolerated.

Criteria for weaning and extubation

1. Hemodynamic stability
2. Surgical hemostasis; chest tube drainage should be less than 1-2 ml/kg/h or less than 100 ml/h
3. Adequate neurologic function
4. No planned intervention
5. Normothermia
6. No acute changes shown on chest X-ray
7. Satisfaction of the respiratory criteria
   - PaCo2 $\leq$ 50 mmHg
   - Arterial pH of $\geq$ 7.32, unless the cause was clearly known and improvement expected.
   - Positive end expiratory pressure $\leq$ 5 cm H_2O
   - Stable chest X-ray
   - Awake without residual neuromuscular blockade

Respiratory criteria for extubation

- Negative inspiratory force $\geq$ -20 cm H_2O
- Vital capacity (VC) $\geq$ 10 ml/kg
- Resting minute ventilation of $\leq$ 10 L
- Maximum voluntary ventilation $\geq$ 2 times resting level
- Patient is comfortable breathing spontaneously with Continuous positive airway pressure (CPAP) of $\leq$ 5 cm H_2O with respiratory rate (RR) < 30/min

RESULTS

Evaluation of extubation time

One hundred and fifty patients were included in this study. Patients who expired (n = 10) were excluded. Mean extubation time of the entire group (n = 150) was 1.82 hours. Of the 150 patients, 76 (50.7%) were early extubated, with a mean extubation time of 1.11 hours. Patients that failed early extubation (n = 74) were categorized into 3 groups. Thirty patients (20%) were extubated within > 2-4 hours, 39 (26%) in > 4-24 hours and 5 (3.3%) after > 24 hours (Table 2). There were 6 patients (4%) who needed to be reintubated within 24 hours, 1 (1.3%) in the early extubation group and 5 (6.8%) in the failed early extubation group.

Table 1. List of pre-operative demographic, intra-operative parameters and post-operative outcome parameters.

Factors
Old age (> 70 yrs)
Gender (Female)
Diabetes mellitus (DM)
Hypertension (HT)
Obesity (30% over ideal body weight)
Renal insufficiency (CRF, Cr > 2)
Chronic obstructive lung disease (COPD)
Cerebrovascular accident (CVA)
Smoking
Dyslipidemia
History of myocardial infarction (MI)
History of congestive heart failure (CHF)
Unstable angina
Left ventricular ejection fraction (LVEF)
Left main disease (LM)
Intra aortic balloon pump (IABP)
Time between operating and closing

Predictors of failed early extubation

Univariate analysis of all variables revealed old age, diabetes, myocardial infarction, congestive heart failure, poor LVEF and IABP used were predictors of failed early extubation (Table 3). Most of the patients presented with multiple risk factors, so multivariate analysis of significant variables was performed using logistic regression. Three variables were significant including old age with adjusted odds ratio of 4.6 (95% CI = 1.5-13.7) $p < 0.01$, diabetes with adjusted odds ratio of 3.2 (95% CI = 1.3-7.5) $p < 0.01$ and IABP used with an adjusted odds ratio of 4.3 (95% CI = 1.3-14.6) $p = 0.02$. (Table 4)

Comment

Evaluation of extubation time

The trend of early extubation has become more popular since the mid 90's[2]. Particularly,

Table 2. Evaluation of extubation time.

Hours	Frequency (n)	Valid %	Mean (h)	SD
0–2 h	76	50.7	1.11	0.50
> 2–4 h	30	20.0	2.91	0.49
> 4-24 h	39	26.0	11.44	7.30
> 24 h	5	3.30	33.3	21.0

Table 3. Univariate analysis of variables associated with failed early extubation.

Factors	Failed early extubation			P-value
	N	Total	%	
Old age				
> 70	25	33	75.8	< 0.01
≤ 70	59	127	46.5	
Gender				
Male	62	126	49.2	0.08
Female	22	34	64.7	
DM				
Yes	51	78	65.4	< 0.01
No	33	82	40.2	
HT				
Yes	53	96	55.2	0.22
No	29	61	47.5	
Obesity				
Yes	5	8	62.5	0.42
No	79	152	52.0	
CRF (Cr > 2)				
Yes	5	7	71.2	0.25
No	76	149	51.0	
COPD				
Yes	10	15	66.7	0.16
No	69	139	49.6	
CVA				
Yes	9	12	75.0	0.08
No	70	141	49.6	
Smoking				
Yes	39	73	53.4	0.40
No	40	80	50.0	
Dyslipidemia				
Yes	62	120	51.7	0.51
No	17	34	50.0	
MI, Hx of				
Yes	58	94	61.7	< 0.01
No	21	60	35.0	
CHF, Hx of				
Yes	32	44	72.7	< 0.01
No	47	110	42.7	
Unstable Angina				
Yes	49	89	55.1	0.15
No	27	60	45.0	
LVEF				
> 40%	35	85	41.2	< 0.01
≤ 40%	39	51	76.5	

Table 4. Multivariate analysis of variables associated with failed early extubation.

Factors	Failed early extubation			P-value
	N	Total	%	
LM				
> 50%	20	34	58.8	0.26
≤ 50%	64	126	50.8	
IABP				
Yes	30	36	83.3	< 0.01
No	54	124	43.5	
Skin to skin time				
> 4.30 h	22	34	64.7	0.06
≤ 4.30 h	59	123	48.0	

Factors	Adjusted OR (95% CI)	P-value
Old age	4.6 (1.5, 13.7)	< 0.01
Sex	1.5 (0.5, 4.2)	0.45
DM	3.2 (1.3, 7.5)	< 0.01
MI	1.4 (0.6, 3.4)	0.48
CHF	1.3 (0.4, 4.4)	0.63
LVEF < 40 %	0.7 (0.2, 2.2)	0.49
IABP	4.3 (1.3, 14.6)	0.02

extubation after On-Pump surgery became routine after 2-6 h in many centers, using the same general criteria already well established[3-6]. When Off-pump surgery got off the ground, early extubation was also employed with success. The authors adopted this policy at the institution and started to use it from the very beginning of the Off-pump procedure.

The present results demonstrated that more than 50 per cent of the OPCAB patients were extubated within 2 hours. The large number of patients who could be extubated early in the present study can be attributed to several factors such as patient preparation, anesthetic regimen, pain control technique, hemodynamic stability, and hemostasis, etc.

The benefit of an anesthetic regimen of low dose narcotic base with short acting inhalation supplement needed to be studied. This regimen provides cardiovascular stability, low incidence of awareness and rapid recovery[7-9]. Rocuronium bromide, with rapid onset and intermediate duration provided optimum time to recover from neuromuscular blockade without the need of reversal[4]. Intravenous fentanyl was chosen for pain control to facilitate early recovery, adequate analgesia, and less respiratory depression[10].

Post-operative hemodynamic stability and surgical hemostasis play crucial roles in extubation time. Many studies comparing on-pump coronary artery bypass graft *vs* OPCAB clearly revealed that OPCAB patients have less blood loss during the post-operative period[11-13]. Thus this could allow even further early extubation and may have enhanced the present results. Keeping the patients at the normothermic level is important not only for rapid anesthetic excretion but for better cardiovascular stability and acid-base balance[14,15].

The total reintubation rate in the present study was 4 per cent. Of these, only 1 patient (1.3%) was in the early extubation group and 5 (6.8%) were in the prolonged extubation group. This compares favorably with results from other studies and indicates that the authors used acceptable criteria for weaning and extubation[5,10]. Moreover, observation, weaning and decision making were carefully done by a cardiac anesthesiologist and cardiovascular and thoracic surgeons.

Predictors of failed early extubation

It is accepted that patients with advanced age who undergo general anesthesia need special care

while attempting early extubation because this group of patients tends to have a sensitive response to narcotics and inhalation agents. Delayed drug excretion due to slow liver and renal clearance prolongs the intubation time[16-18]. The present results demonstrated that old age is a predictor of failed early extubation both in univariate and multivariate analyses.

Theoretically, well controlled diabetes does not affect the intubation time in general anesthesia. In the present study, however, it was a significant predictor in both univariate and multivariate analyses. Most diabetics have multiple and diffuse anatomical lesions, which make it difficult to accomplish the anastomosis and require longer lifting and manipulation of the hearts. This could cause cardiovascular instability and prolong the operative time. In poorly controlled diabetes, peripheral and autonomic neuropathy will further compromise the body heat control system causing hypothermia. In daily practice, the authors control blood sugar in all diabetics with insulin infusion and frequent blood sugar test. The treatment also induces a shift of potassium into the cells, which in turn lowers the threshold of dysrhythmia. The authors have observed that diabetic patients have a greater tendency to develop dysrhythmia during OPCAB than non-diabetics; however this has not been proved clinically.

Most of the presented patients with IABP were intubated prior to operation or underwent emergency/urgent operations. The authors did not use IABP routinely for patients with poor LVEF; and it was found that these patients tolerated the OPCAB procedure better than the bypass[19]. The authors seldom used IABP in the operating room but used it mainly after profound hemodynamics instability; these patients tended to have dysrhythmia and low cardiac output post-operatively and required longer intubations time.

Previous studies revealed that female gender, COPD, morbid obesity, renal insufficiency, and CVA are predictors of failed early extubation[16,20-23]. The present results, however, did not support these findings. This could due to difference in the patients' demographics or the small number of patients in each subgroup.

In short, early extubation with more than 50 per cent of overall OPCAB cases were accomplished during the learning curve at Bangkok Heart Institute. Good pre-operative planning, intra-operative detail on the hemodynamics and metabolic changes and prompt correction have made early extubation feasible.

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OPCAB Surgery : ประเมินเวลาใส่ท่อช่วยหายใจและปัจจัยเสี่ยงบ่งชี้ผู้ป่วยใส่ท่อ-ช่วยหายใจนาน

ประนอม คัมภีรวุฒิ, พบ, กิติพันธ์ วิสุทธารมณ์, พบ*, วิบูลย์ โชติสกุลรัตน์, พบ*, วิฑูรย์ ปิติเกื้อกูล, พบ*, สุจิตร์ บัญญัติปิยพจน์, พบ*, ปิยพันธ์ ภมรสิงห์, พบ**

การดูแลผู้ป่วยระหว่างและหลังผ่าตัด Off-pump coronary artery bypass surgery หรือ OPCAB มีความสำคัญอย่างยิ่งต่อผลการผ่าตัด ระยะเวลาใส่ท่อช่วยหายใจมีความสัมพันธ์โดยตรงต่อการฟื้นตัวของผู้ป่วยในไอซียูและระยะเวลาที่อยู่โรงพยาบาล การศึกษานี้เพื่อประเมินระยะเวลาที่ผู้ป่วยใส่ท่อช่วยหายใจและปัจจัยเสี่ยงที่บ่งชี้การใส่ท่อช่วยหายใจนานของศูนย์-หัวใจกรุงเทพ

ได้มีการศึกษาผู้ป่วยแบบย้อนหลัง ระหว่างมกราคม 2544 – มิถุนายน 2545 จำนวน 160 คน โดยยกเว้นผู้ป่วยที่มีท่อเจาะคอ ก่อนผ่าตัดจำนวน 1 คน ยาดมสลบที่ใช้ ได้แก่ fentanyl, rocuronium, midazolam และ sevoflurane ควบคุมความดันโดย phenylephrine และ nitroglycerine หลังผ่าตัดควบคุมความเจ็บปวดด้วยยา fentamyl และ ยาแก้ปวดแบบรับประทาน

การประเมินระยะเวลาใส่ท่อช่วยหายใจแบ่งเป็น 4 กลุ่ม; 0–2 ชั่วโมง n = 76 (50.7%) ค่าเฉลี่ย = 1.11 $\pm$ 0.5 ชั่วโมง, > 2–4 ชั่วโมง n = 30 (20%) ค่าเฉลี่ย = 2.91 $\pm$ 0.5 ชั่วโมง, > 4–24 ชั่วโมง n = 39 (26%) ค่าเฉลี่ย = 11.4 $\pm$ 1.3 ชั่วโมง และ > 24 ชั่วโมง n = 5 (3.3%) ค่าเฉลี่ย = 33.3 $\pm$ 21 ชั่วโมง

การศึกษาปัจจัยเสี่ยง เพื่อบ่งชี้การใส่ท่อช่วยหายใจนาน (> 2 ชั่วโมง) พบว่ามีตัวแปร 3 ตัวที่บ่งชี้การใส่ท่อ-ช่วยหายใจนานอย่างมีนัยสำคัญ คือผู้ป่วยสูงอายุ โดยมี odds ratio (OR) = 4.6 (95% CI = 1.5–13.7) $p < 0.01$, ผู้ป่วยเบาหวาน OR = 3.2 (95% CI = 1.3–7.5) $p < 0.01$ และผู้ป่วย intraaortic balloon pump (IABP) OR = 4.3 (95% CI = 13–14.6) $p = 0.02$

ที่ศูนย์หัวใจกรุงเทพผู้ป่วยมากกว่า 50% สามารถถอดท่อช่วยหายใจภายใน 2 ชั่วโมง (เฉลี่ย 1.11 $\pm$ 0.5 ชั่วโมง) และมีเพียง 5 คนที่ถอดท่อช่วยหายใจหลัง 24 ชั่วโมง จากการศึกษาพบว่าการถอดท่อช่วยหายใจในผู้ป่วย OPCAB ภายใน 2 ชั่วโมงสามารถทำได้ และควรระมัดระวังเป็นพิเศษในผู้ป่วยสูงอายุ, เบาหวาน และผู้ป่วย IABP

คำสำคัญ : ผู้ป่วยใส่ท่อช่วยหายใจนานใน OPCAB

ประนอม คัมภีรวุฒิ, กิติพันธ์ วิสุทธารมณ์, วิบูลย์ โชติสกุลรัตน์, วิฑูรย์ ปิติเกื้อกูล, สุจิตร์ บัญญัติปิยพจน์, ปิยพันธ์ ภมรสิงห์
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ศูนย์หัวใจกรุงเทพ, โรงพยาบาลกรุงเทพ, กรุงเทพ ฯ 10320