EARLY EXTUBATION ANESTHESIA IN CARDIAC VALVE SURGERY

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Abstract

Background: The increasing number of cardiac valve surgeries, intensive care and economic pressures have led to the concept of fast track cardiac surgery in which early extubation (within 6 - 8 hours after surgery) is the key issue. This study was conducted to assess the feasibility and safety of early extubation in patients undergoing valve surgery. **Patients and method**: Eighty four adult patients undergoing elective valve surgery under cardiopulmonary bypass were included in this study. Operative procedures included primary valve repair and replacement at Hue Cardiovascular Center. Anesthesia was induced with sufentanil, etomidate and vecuronium, maintained with isoflurane and cardiopulmonary bypass with mild hypothermia was applied. **Results:** Three patients were excluded due to reoperation for bleeding. Extubation time was 6.94 ± 2.09 hours, early extubation rate was 81.5%, extubation before 6 hours after surgery 39.5%. No patients had respiratory depression, required reintubation or supplemental catecholamines. **Conclusions**: Early extubation was feasible and safe in patients with reserved cardiac function undergoing valve repair or replacement under cardiopulmonary bypass with mild hypothermia.

Key words: *Early extubation, cardiac surgery.*

1. INTRODUCTION

Every year, thousands of patients need cardiac surgery. Valve repair or replacement is a highly specialized and complex procedure. During the procedure, cardiopulmonary function is replaced by extracorporal circulation (ECC). Postoperative cardiopulmonary function is severely impaired, the heart needs time to respond to new conditions. Anesthesia using high doses of opioids with postoperative mechanical ventilation from 12 to 24 hours has become standardized in the 1980s [10]. Prolonged ventilation increases the postcardiac intensive care time, the number of beds and personnel in the intensive care unit (ICU). Moreover, prolonged ventilation is associated with an increased risk of morbidity and mortality, particularly nosocomial infections, thereby increases treatment costs, reduces the number of surgical patients.

The development of anesthesia technique, ECC, myocardial protection during ECC and surgical techniques have changed the course of postoperative patients. Along with the augmentation in the number of patients undergoing cardiac surgery and economic pressure for cost effective medical care, while ensuring the safety of patients, fast-track cardiac surgery appeared during the early and mid 1990s, in which early extubation was the principal issue. Early extubation is a removal of endotracheal tube within 6-8 hours after surgery [4]. Early extubation reduces ICU and hospital stays, so shorter ICU and hospital stays also mean that more operations might be performed. This method has now become the standard and is applied in most cardiac surgical centers worldwide [12]. The objective of this study was to assess the feasibility and safety of early extubation in cardiac valve surgery.

2. PATIENTS AND METHODS

The ethical committee of the hospital approved this prospective descriptive study, written informed consent was obtained from 84 patients scheduled for primary elective valve repair or replacement via median sternotomy. Patients who were under 18 or over 60 years old, had an ASA

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physical status IV, a neurological disorder, chronic diseases such as chronic lung diseases, liver and kidney failure, systolic pulmonary artery pressure more than 70 mmHg, left ventricular ejection fraction under 50%, had contraindications of spinal anesthesia were excluded.

Patients received 50 mg of hydroxyzine orally the night before surgery and the same dose one hour before being transferred to the operating room. In the operating room, patients were monitored by continuous ECG and ST-analysis, pulse oximetry, and an invasive arterial line inserted in the left radial artery under local anesthesia and a peripheral intravenous line. All patients were injected morphine of 0.3 mg intrathecally, diluted in 3 ml of normal saline at the L_2-L_3 interspace prior to induction of general anesthesia.

After pre-oxygenation, general anesthesia protocol of Hue Central Hospital was followed. Patients received sufentanil dose of 0.5 µg/kg, etomidate of 0.3 mg/kg, vecuronium bromide of 0.1 mg/kg, followed by a continuous infusion at 0.2 µg/kg/h of sufentanil. Mechanical ventilation was initiated with a tidal volume of 10 ml/kg, respiratory frequency of 12 cycles per minute, oxygen inspired fraction of 50%. A nasoesophageal thermometer, bladder catheter, and central venous catheter were inserted after anesthesia induction.

Anesthesia was maintained with either an adjustment of the isoflurane concentration or a bolus of sufentanil 0.2 µg/kg to maintain systolic blood pressure and heart rate within 20% of preoperative baseline values. During cardiopulmonary bypass, hypnosis was maintained with a propofol infusion at the rate of 4 mg/kg/h. ECC was undertaken with mild hypothermia. Sufentanil infusion was terminated at the moment of skin closure.

Tracheal extubation criteria as follows:

Consciousness: Fully awake, responsive to commands.

Central temperature above 36 degrees Celsius, absence of shivering.

Hemodynamic stability

Urine output more than 0.5 ml/kg/h

No repiratory depression, acceptable artery blood gases and no pnemothorax, hemothorax on chest X-ray.

Decurarisation

Effective postoperative analgesia

Thoracic drainage less than 30 ml/h.

Mechanical ventilation, extubation time, number of patients requiring reintubation or supplemental catecholamines and changes in artery blood gases were recorded.

3. RESULTS

A total of 84 patients were enrolled in the study, 3 patients were reoperated due to bleeding. The findings on 81 patients were presented in the following tables.

Table 1. Patient characteristics

Parameters	Values (n = 81)
Age; year	38.6 ± 14.4
Height; cm	159.3 ± 7.2
Weight; kg	50.75 ± 7.01
NYHA II/III n (%)	66/15 (81.5/18.5%)
EF (%)	56.3 ± 6.8
Pulmonary artery pressure (mmHg)	46.7 ± 12.3

Values are expressed as mean ± SD or number of patients.

Middle-aged patients, average age 38.6 ± 14.4, had heart failure, impaired left ventricular ejection fraction and severely pulmonary artery hypertension.

Table 2. Surgical procedures

Parameters	n (%)
Mitral valve repair	9 (11.1)
Mitral valve replacement	32 (39.5)
Mitral valve replacement, tricuspid valve repair	11 (13.6)
Aortic valve replacement	12 (14.9)
Mitral or aortic valve replacement	17 (20.9)

The mitral valve repair or replacement was prominent.

Table 3. Anesthesia, surgical characteristics

Parameters	Values (n = 81)
Duration of surgery (min)	218.6 ± 43.6
Cardiopulmonary bypass (min)	102.2 ± 36.1
Aortic cross clamp time (min)	73.9 ± 31.9
Anesthesia time (min)	257.0 ± 46.9
Etomidat (mg)	15.6 ± 1.8
Propofol (mg)	364.2 ± 114.8
Vecuronium (mg)	12.9 ± 2.6
Sufentanil (µg)	88.9 ± 19.5

Table 4. Mechanical ventilation, extubation

Parameters	Values (n = 81)
Mechanical ventilation (h)	4.85 ± 2.12
Extubation (h)	6.94 ± 2.09
Extubation before 6 h	32/81 (39.5 %)
Extubation within 6 - 8 h	34/81 (42.0%)
Early extubation	66/81 (81.5%)
Extubation after 8 h	15/81 (18.5%)

The incidence of early extubation was 81.5%, of extubation after 8 hours 18.5%, in which 9.9% (8/81) underwent on the mitral or aortic valve associated with tricuspid valve, no patients had been reintubated or received supplemental catecholamines.

Table 5. Blood gases before and after extubation

Parameters	Before extubation (n = 81)	After extubation (n = 81)	p
pH	7.398 ± 0.669	7.384 ± 0.656	> 0.05
$PaCO_2$ (mmHg)	34.83 ± 6.64	38.57 ± 7.53	< 0.05
PaO_2 (mmHg)	184.32 ± 39.56	146.01 ± 44.97	< 0.05
HCO_3^- (mEq)	21.04 ± 2.73	22.49 ± 2.94	< 0.05
SaO_2 (%)	99.18 ± 5.93	98.35 ± 1.49	< 0.05

There was no difference in pH, but $PaCO_2$, PaO_2, HCO_3^-, SaO_2 before and after extubation.

4. DISCUSSION

The study showed that patients with reserved cardiac function could be early extubated after surgery, extubation time was 6.94 ± 2.09 hours, the rate of early extubation was 81.5%, the rate of extubation before 6 hours 39.5%. It means extubation may be earlier. Extubation time in this study was equivalent to Pham Thi Le Xuan et al (232.45 ± 42.52 minutes), the authors studied early extubation anesthesia in patients undergoing open cardiac surgery with midazolam, propofol, vecuronium and fentanyl, total dose of 14.5 µg/kg [2].

The most important things in anesthesia for early extubation are the patient selection and anesthetic drug use. The patients with reserved cardiac function are selected in this protocol. In term of drug use, reducing the cumulative dose and selecting opioids of short duration of action, administrating intravenous continuous infusion or volatile anesthesia (to achieve the target concentration in the brain) and optimizing the drug interactions between opioid and hypnotic drugs are essential. Using short-acting muscle relaxants, monitoring the residual neuromuscular blockade and antagonizing the effects of muscle

relaxants of long-acting are required. Sedation in the recovery room for a short time (1-4 hours) sufficient to assess extubation criteria, preventing hypothermia after surgery, internal and surgical strategies for excessive bleeding prevention after surgery and effective postoperative pain management are applied [15]. In this study, patients with mild impaired cardiac function (ventricular ejection fraction 56.3±6.8%), low sufentanil dose (88.9±19.5μg), intrathecal injection of morphine prior to induction for postoperative pain management meet the requirements of early extubation anesthesia.

Extubation at what time to avoid both the detrimental impact on the heart, lung function and unnecessary discomfort for the patient is still difficult to identify before surgery. Depending on the patient's condition before surgery, anesthetic regimen, and the monitoring of patients in the ICU, anesthesiologists can extubate or continue ventilation. According to Cheng, Hawkes [3], [4] early extubation was tube removal within 8 hours from the patient's arrival to the ICU.

Higgins [5] defined the concept of "extubation window", estimated between 3 and 10 hours after admission to the ICU. In this period, the patient has overcome the phase of risks of premature extubation (hemodynamic instability, thrill, bleeding) and the complications related to prolonged ventilation (patient discomfort requiring increased sedation, ciliary dysfunction in tracheobronchial, inability to cough, atelectasis) have not occurred. Nguyen Thi Quy et al applying early extubation anesthesia on patients with valve surgery concluded that sufentanil combined with propofol group had shorter extubation time than fentanyl group (135.36 ± 46.53 versus 517.14 ± 257.70 minutes) and was within extubation window [2].

Some authors have extended this approach to immediate extubation in the operating room [6],[11]. This seems much more controversial because it could increase the incidence of cardiorespiratory complications, myocardial ischemia, reintubation, hypothermia, chills and inadequate analgesia. Indeed, most of the cardiac events resulting from myocardial ischemia, perioperative infarctus, or inadequate myocardial protection occur most often during the first postoperative hours [8]. In addition, we must not forget that cardiac surgery remains a potentially hemorrhagic surgery, in this case requiring surgical re-exploration whose incidence varies between centers, 1.5 to 3% [9]. On the other hand, most patients have made a discreet hypothermia after surgery, due to an incomplete warming after ECC, the action of anesthetic agents that block the thermoregulatory mechanisms, with a gradient persistance between the central compartment and the periphery. This hypothermia can induce deleterious effects. A lower body temperature at 35.5°C is indeed associated with a higher incidence of myocardial ischemia, hypertension, shivering and bleeding. In particular, shivering causes a steep rise in the consumption of oxygen by the organism which can be detrimental due to increased heart rate, stimulation of the sympathetic nervous system and the onset of lactic acidosis. Finally, the incidence of neurological complications varies from 4.2 to 13% for open - heart surgery and from 0.6 to 5.2% for the coronary artery bypass graft surgery. Therefore, extubation in the operating room bypasses the observation period, diagnosis and assessment of severity of neurological deficit, which may lead to increased risk of inhalation and respiratory complications [13]. In this study, 39.5% of patients were extubated before 6 hours, as this may further reduce postoperative extubation time. Other studies are needed to evaluate this issue.

Potential advantages of early extubation include 1) Less airway irritation and ventilator-associated complications, such as accidental extubation, laryngotracheal trauma, pulmonary hypertensive crisis during endotracheal tube suctioning, mucous plugging of endotracheal tubes, barotrauma secondary to positive airway pressure ventilation, and ventilator-associated pulmonary infections and atelectasis; 2) Reduced requirements of sedatives (and associated hemodynamic compromise); 3) More rapid patient mobilization; 4) Earlier ICU Discharge; 5) Decreased length of hospital stay; and 6) Reduced costs (ventilator-associated and length of ICU/hospital stay). Controlled mechanical ventilation is generally considered mandatory or beneficial in all patients who are hemodynamically unstable, coagulopathic patients [7]. Limitation of the study was not to evaluate this aspect. A randomized controlled trial must be implemented to compare this aspect and the cost-savings between early and late tracheal extubation (over 10 hours).

Wong et al [14] introduced the concept of delayed extubation (over 10 hours) and the risk factors for late extubation, including age over 60,

female gender, emergency surgery, myocardial infarction less than 1 month, renal insufficiency, preoperative inotropes, intraaortic balloon pump, cardiac pacing, cardiopulmonary bypass over 120 minutes; postoperative inotropes, intraaortic balloon pump, atrial arrhythmias, excessive bleeding. Selection criteria in this study did not include patients with risk factors for delayed extubation. As a result, no patients had respiratory depression, needed reintubation or additional catecholamines. Thus, early extubation was safe. The incidence of extubation after 8 hours was 18.5%, including 9.9% (8/81) cases of intervention on mitral or aortic valve associated with tricuspid valve. Intervention at the same time on two heart valves with prolonged anesthesia, surgery and cardiopulmonary bypass can be one of explainations.

In artery blood gases, the pH before and after extubation did not differ significantly, but $PaCO_2$ after extubation was higher than those before extubation. This may be due to irritation of endotracheal tube, stimulating the patients breath rapidly, after extubation respiratory rate slows. After extubation, $PaCO_2$ increased so the body started the regulation mechanism to increase HCO_3^-. PaO_2 and SaO_2 decrease after extubation, however these values were within normal limits. In summary, the changes of artery blood gases before and after extubation had little clinical significance.

5. CONCLUSION

By applying early extubation anesthesia on 84 patients with reserved cardiac function undergoing valve surgery, we concluded that early extubation after valve repair or replacement was feasible and safe. Extubation time was 6.94 $\pm$ 2.09 hours, the rate of early extubation of 81.5%, the rate of extubation before 6 hours was 39.5%. No patients experienced respiratory failure, needed reintubation or additional catecholamines.

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