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Less Invasive Cardiac Anesthesia: An Ultra–Fast-Track Procedure Avoiding Thoracic Epidural Analgesia

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ABSTRACT

Background and Objective: A new "less invasive" technique avoiding thoracic epidural analgesia has been tested for suitability as a routine procedure for cardiac anesthesia. Early postoperative extubation is an important step in this fast-track procedure.

Materials and Methods: Consecutive patients (n = 547; age, 35-82 years; mean age, 64 years; male to female ratio, 3.5) underwent general anesthesia with ultra–short-acting opiates and then underwent coronary surgery (n = 465), valve surgery (n = 38), or combined and other procedures (n = 44). In 51.4% cases, coronary artery bypass grafting was performed off pump. The percentage of patients extubated within 10 minutes after skin closure was the primary end point. In addition, we attempted to identify the limiting factors of the procedure tested.

Results and Discussion: Of the 547 patients, 499 (91%) were extubated within 10 minutes after skin closure. Early extubation failed in 48 (9%) of the patients. The mortality rate was 1.5%. One (0.2%) of the patients needed early reintubation because of pneumothorax. Postoperative myocardial ischemia was recorded in 10 (1.8%) of the patients. Ninety-six (17.5%) of the patients were treated pharmacologically for newly developed atrial fibrillation. None of the patients needed hemodialysis. Transient neurological disorders were recorded in 10 (1.8%) of the patients. The early extubation failure group showed statistically significantly higher rates of preoperative lung dysfunction, use of extracorporeal circulation, administration of inotropic drugs in the operating room, and statistically significantly longer duration of surgery.

Conclusion: Early extubation proved suitable as a routine procedure for the vast majority of patients. With a good postoperative analgetic protocol, there is no need for thoracic epidural analgesia. Such avoidance of thoracic epidural analgesia is a further step in minimizing invasiveness in cardiac surgery.

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INTRODUCTION

The new interest in procedures on a beating heart and development of less invasive techniques for cardiac surgery bring new tasks for anesthesia. Advanced surgical techniques coupled with reliable anesthesia and fast postoperative rehabilitation are the priorities of so-called fast-track protocols. Early extubation, preferably still in the operating room, is crucial in ultra–fast-track protocols [Djaiani 2001]. Recent extensive studies have shown that early extubation has no negative effect on postoperative morbidity and mortality and that this method has the advantages of allowing fast postoperative rehabilitation, reducing need for skilled-nursing care and saving costs [Royse 1999, Vricella 2000, Oxelbark 2001]. For these reasons, fast-track anesthesia should be further developed and standardized. All fast-track anesthesia protocols published as of this writing have used general intubation anesthesia in combination with thoracic epidural analgesia. In an attempt to make less invasive not only the surgical procedure but also anesthesia, we suggest a method of anesthesia without thoracic epidural analgesia and with extubation in the operating room. We discuss experience gained by implementation of this technique in clinical practice.

MATERIAL AND METHODS

Primary End Point

The percentage of patients extubated within 10 minutes after skin closure was the primary end point. In addition, we attempted to identify the limiting factors of the procedure tested.

Patients and Surgical Techniques

Between January 2001 and March 2002, 547 unselected consecutive adult patients underwent cardiac surgery. Data on this population are reported in Table 1. The mean age was 64 years, and the male to female ratio was 3.5. Left ventricular ejection fraction ranged from 25% to 65%. Aortic occlusion time ranged from 16 to 104 minutes (mean, 31 minutes), and extracorporeal circulation (ECC) time varied from 29 to 203 minutes (mean, 56 minutes). Of the procedures, 281 (51.4%) were performed off pump. Duration of the surgical procedure ranged from 90 to 360 minutes (mean, 199 minutes). The protocol was applied in treatment of patients undergoing coronary artery bypass grafting, valve surgery, redo procedures, and combined procedures. The operative procedures used are listed in Table 2.

Table 1. Demographic Data*

Total no. of patients	547 (100%)
Male to female ratio	3.5
Mean age, y	64 (range, 35-82)
Hypertension	337 (62%)
Diabetes mellitus	147 (26%)
Compromised kidney function with creatinine >150 μmol/L	27 (5%)
Lung dysfunction with FEV_1 <75% predicted	102 (19%)
Neurological disorder in history	64 (11.7%)
EF <30%	26 (4.8%)
EF 30%-50%	150 (27.4%)
EF >55%	371 (67.8%)

*FEV_1 indicates forced expiratory volume in 1 second (L/s); EF, ejection fraction.

Anesthesiology Protocol

All patients were premedicated with 50 mg pethidine and 0.5 mg atropine. Anesthesia was induced by intravenous remifentanil (0.5 μg/kg per minute) and a 40-mg bolus dose of propofol. Atracurium dosed 0.6 mg/kg was used as a muscle relaxant. Remifentanil and isoflurane were used to maintain anesthesia. Intravenous atracurium at a dose 0.3 mg/kg per hour was given to continue muscle relaxation. Attention was paid to the patient's normothermia achieved by means of a heating mat, higher ambient temperature, administration of heated intravenous fluids, and heated ECC blood.

Patient Monitoring

Standard monitoring of patients included thorough measurement of body temperature by means of a nasopharyngeal thermometer. If needed, standard monitoring was completed with continuous cardiac output and mixed venous saturation measurements.

Criteria for Extubation in the Operating Room

Basic criteria for extubation in the operating room included fully controlled hemodynamics, adequate patient consciousness, sufficient muscle strength, and absence of both lung failure (particularly if ECC was used) and early surgical complications. These criteria are summarized in Table 3.

Table 2. Surgical Procedures

Total no. of patients	547 (100%)
Direct myocardial revascularization	465 (85%)
Aortic valve replacement	31 (5.7%)
Mitral valve replacement	7 (1.3%)
Combined procedures	28 (5.1%)
Other procedures	16 (2.9%)
Off-pump procedures	281 (51.4%)
Mean duration of extracorporeal circulation, min	56 (29-203)
Mean duration of cold ischemia, min	31 (16-104)
Mean duration of surgery, min	199 (90-360)

Postoperative Analgesia

Metamizole was administered intramuscularly at a dose of 2.5 g, and intravenous administration of remifentanil was continued at a dose 0.0125 to 0.05 μg/kg per minute.

Statistical Analysis

Chi-square test and *t* test were used for statistical analysis of possible limiting factors (chi-square: sex, ejection fraction, lung dysfunction, hypertension, diabetes, neurological disorder in history, chronic renal insufficiency, use of ECC, use of inotropic drugs in operating room; *t*-test: mean age, mean surgery duration, mean cold ischemia duration).

RESULTS

Fast-track anesthesia and extubation in the operating room, if feasible, were used in 547 procedures. Extubation in the operating room within 10 minutes after the end of surgery was successful in 499 (91%) of the patients. Early extubation failed in 48 (9%) of the patients. Data on the postoperative course are given in Table 4. The mortality rate was 1.5%. One (0.2%) of the patients needed early reintubation because of pneumothorax. Postoperative myocardial ischemia was recorded in 10 (1.8%) of the patients. Ninety-six (17.5%) of the patients were treated pharmacologically for newly developed atrial fibrillation. None of the patients needed hemodialysis. Transient neurological disorders were recorded in 10 (1.8%) of the patients.

The early extubation failure group showed statistically significantly higher rates of preoperative lung dysfunction ($P = .0017$), use of ECC ($P = .0001$), administration of inotropic drugs in the operating room ($P < .001$), and statistically significantly longer duration of surgery ($P < .0001$).

DISCUSSION

Requirements for less invasive cardiac surgery, particularly if completed on a beating heart, imply the need for new anesthesia procedures. Traditional medium- to high-fentanyl (stress-free) anesthesia is associated with a need for prolonged artificial pulmonary ventilation and a long stay in the postoperative care unit. New procedures of fast-track anesthesia are based on the use of ultra–short-acting drugs and necessitate a highly active approach to the entire course of anesthesia. The early postoperative period is known to be

Table 3. Tracheal Extubation Criteria*

Hemodynamics	Normotension, heart rate <115 beats/min, no signs of low cardiac output or myocardial ischemia
Lung function	PaO_2 >80 mmHg at FiO_2 0.5
Muscle strength	Spontaneous smooth ventilation for >20 min, patient can lift head
Consciousness	Full contact with patient responsive to simple commands
Surgery complications	Bleeding <200 mL within last 30 min

*FiO_2 indicates fraction of inspired oxygen.

Table 4. Postoperative Course

Total no. of patients	547 (100%)
Extubated in the operating room	499 (91%)
Early extubation failure	48 (9%)
Needed reintubation	1 (0.2%)
Mortality rate	8 (1.5%)
Postoperative myocardial infarction	10 (1.8%)
Postoperative atrial fibrillation	96 (17.5%)
Hemodialysis	0
Postoperative neurological disorder	10 (1.8%)

critical for development of myocardial ischemia and circulatory instability because of uncontrolled sympathetic activation. At the end of fast-track–protocol surgery, the circulation essentially differs from that observed with classic procedures [Lee 2000, Montes 2000, Peragallo 2000]. The need for β-mimetics decreases, whereas that for β-blockers increases.

Two less expected but highly topical problems were maintenance of normothermia and adequate postoperative analgesia. To achieve normothermia at the end of surgery, the entire procedure has to be conducted with the least possible fluctuation of temperature. If ECC is used, the problem can be solved by active heating of the blood. In the patients who did not need ECC, normothermia was achieved by the usual means, such as a heating mat, heated intravenous fluids, and a heated operating room, even if less comfortable for the operating team. The patients continued to be heated in the postoperative care unit. Sporadic shivering was successfully controlled with low-dose intravenous tramadol.

The use of an ultra–short-acting opioid with volatile anesthetics is associated with the need for adequate postoperative analgesia. For the study group of patients, a unique technique of fast-track anesthesia without thoracic epidural analgesia was used to achieve "less invasive anesthesia." The combination of intramuscular metamizole and continuing intravenous remifentanil proved to be best for postoperative analgesia.

The described technique of fast-track anesthesia was initially intended for surgical procedures on a beating heart. This type of anesthesia has been used progressively for all of our patients. A surprising finding has been that patients with significantly impaired left ventricular function appear to benefit most from this technique. The hypothesis of the favorable effect of quickly restored autoregulation in these patients remains to be proved.

For technical reasons, intensive care duration and hospital stay were not considered study end points. Nevertheless, we can safely say that after 6 hours in the intensive care unit, most of the patients no longer needed invasive monitoring.

CONCLUSION

On the basis of the data presented, the vast majority of patients undergoing cardiac surgery can be extubated in the operating room. This technique proved safe and was not associated with a higher percentage of complications compared with conventional procedures. Early mobilization, lower need for skilled nursing care, and cost savings are the major advantages of this method.

With a good postoperative analgetic protocol, there is no need for thoracic epidural analgesia, and a further step has been taken in minimizing the invasiveness of cardiac surgery.

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REVIEW AND COMMENTARY

1. Editorial Board Member DB515 writes:

This an important contribution, and I am happy to see quality anesthesia papers in *The Heart Surgery Forum*. The results are impressive, and I believe many readers will have practical benefit of this paper.

Just a question for additional comment: The problem of hypothermia is indeed important in off-pump coronary artery bypass grafting (OPCAB), especially in multiple grafting, resident teaching, and long procedures. We have found the best method for warming to be the so-called cappuccino technique, in which hot air is blown on the patient's head and upper body (shoulders). Have the authors tried this? This method makes it unnecessary to heat the room, which can make the procedure uncomfortable for personnel.

Author's Response by Peter Jan Brucek, MD:

I agree that long procedures on a beating heart (OPCAB) in the course of which the patient cannot be warmed via the extracorporeal circuit pose the problem of hypothermia. To remedy this drawback, we use a heating mat and heated drip. The ambient air in the operating room is heated just before the very end of the procedure. The patient can feel more comfortable on awakening, and the staff can easily cope with higher temperature in the room because stress is relieved. Warming similar to the cappuccino technique is used postoperatively in

the intensive care unit (ICU), where the patient is warmed by a whole-body heating blanket.

2. Editorial Board Member SO155 writes:

This paper has a good number of patients, good results, and very important practical implications. Not clear to me is whether there were cases of reoperation because of bleeding or the implications of extubation. In cases of atrial fibrillation, were there any cases in which the better treatment would be use of a defibrillator?

Author's Response by Peter Jan Brucek, MD:

In our study group, 3.6% of patients needed revision procedures for bleeding. These patients were reintubated several hours after the primary procedure, were given anesthesia of the same type, and underwent early extubation again. Because there was no interference with the primary end point of the study, ie, early extubation, this point was not discussed in the paper. All patients enrolled met the early extubation criteria, including absence of bleeding at skin closure.

In this study group, postoperative atrial fibrillation was recorded in 17.5% of patients. Electrocardioversion was not performed on any of them. For years, the mean rate of postoperative atrial fibrillation has been rather stable at our department, reaching approximately 20%. Synchronized cardioversion is restricted to acute tachyarrhythmias with hemodynamic compromise. Amiodarone and digoxin are drugs of choice for this indication.

3. Editorial Board Member NC124 writes:

It would be interesting if the authors added some data regarding the length of stay in the ICU and total length of stay and compared those data with those for a random group of patients who did not receive early extubation. Discussion of the cost reduction also would be interesting.

Author's Response by Peter Jan Brucek, MD:

Because local reimbursement regulations require a minimum ICU and hospital stay for registration for a fee for cardiac surgery, we did not choose shorter ICU or hospital stay as end points of this study. However, from a medical perspective, few patients needed an ICU stay longer than 6 hours.

4. Editorial Board Member MB134 writes:

I object to the words *less invasive* in the title and in the article. I understand the concepts, but I prefer to reserve the words *less invasive* for a procedure, not a choice of drugs. I would strongly recommend the authors change the title, emphasizing operating room extubation or ultra–fast-track extubation.

Author's Response by Peter Jan Brucek, MD:

We use the words *less invasive* to point out that this type of anesthesia differs substantially from other fast-track techniques with the use of an epidural catheter. The dramatically shortened intubation time also reduces the invasiveness of the procedure. The choice of medicaments only enables performance of this new technique.