Result of early extubation in congenital heart surgery: experience in Songklanagarind Hospital

Abstract:
Result of early extubation in congenital heart surgery: experience in Songklanagarind Hospital
Chetpaophan A, Rergkliang C, Chittithavorn V, Vasinanukorn P, Chanchayanon T.
Division of Cardiovascular and Thoracic Surgery, Department of Surgery,
Department of Anesthesiology,
Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla, 90110, Thailand
E-mail: capirak@medicine.psu.ac.th
Songkla Med J 2005;23(Suppl 2):181-186

Fast track extubation is now becoming the preferred postoperative care for congenital heart surgery. This prospective study aims to evaluate the effect of an early extubation practice among pediatric patients submitted to congenital cardiac surgery. From August 2001 to July 2003, 56 patients with congenital heart disease who underwent open heart surgery were enrolled in this study. An early extubation practice group (n = 27) were compared with the conventional postoperative cardiac care (n =

1MD., Lecturer 2MD., Assist. Prof., Division of Cardiovascular and Thoracic Surgery, Department of Surgery
3MD., Assist. Prof., Department of Anesthesiology, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla, 90110, Thailand
Introduction

In open heart surgery, cardiopulmonary bypass (CPB) induces profound physiological changes not only in the cardiovascular system but in other body systems as well. Postoperative pulmonary dysfunction in patients undergoing cardiopulmonary bypass is a significant clinical problem which has long been recognized by cardiac surgeons, anesthetists, and intensive-care physicians. Recovery from the changes can take hours or days even in patients with no further complications. For this reason, it is common practice to maintain patients sedated and mechanically ventilated until the morning following surgery, especially pediatric patients. Recent evidence has suggested that modifying anesthetic techniques and postoperative sedation protocols may allow for early extubation and thereby early ICU discharge, in a process termed “fast-track” management. Recently, a number of studies have shown that modifying anesthetic techniques and postoperative sedation protocols may allow for early extubation and thereby early ICU discharge, in a process termed “fast-track” management. Early extubation is an essential stage in the “fast-track” protocol and, importantly, is a prerequisite before any changes to ICU organization can occur.

In the last few years, several studies have addressed the issue of early extubation and shown that ventilation times can be...
reduced without increased risk to patients. Lower costs in the postoperative period, mainly due to a reduction in ICU and hospital length of stay, can also be achieved. In our institution, some carefully selected patients were considered for a simple intraoperative anesthetic management that allowed early extubation and shortening of the length of intensive care and hospital stay.

This study was undertaken to analyze the possible consequences on morbidity and mortality of an early extubation practice among pediatric patients undergoing congenital cardiac surgery.

Materials and methods

Between August 2001 and July 2003, 66 patients younger than 15 years of age with congenital heart disease who underwent an open-heart operation were enrolled in this study. Ten were excluded due to (i) severe pulmonary hypertension, (ii) cyanotic heart disease, (iii) complex congenital heart disease, and the remaining patients were allocated to a study or control group. The prospective data from 27 patients using an early extubation practice were compared with data from 29 patients in the conventional postoperative cardiac care.

The anesthetic technique was similar in all patients. Pre-medication consisted of diazepam 0.2 mg/kg or chloral hydrate 50 mg/kg orally 30 minutes before induction of anesthesia. After pre-medication and during transfer to the operating room, the patients received oxygen cannula 2 L/min or oxygen mask 5 L/min. In the operating room, the patients were monitored by an electrocardiogram (ECG), noninvasive blood pressure, a pulse oximeter, a capnography, direct arterial pressure line (A–line), central venous pressure (CVP) and thermometer. Anesthesia was induced with a small dose midazolam 0.02–0.04 mg/kg plus fentanyl 2–5 microgram/kg and propofol 1 mg/kg. Cisatracurium 0.15 mg/kg was used as the muscle relaxant for intubation after loss of consciousness. After tracheal intubation, anesthesia was maintained with 50% N₂O/air in the oxygen supplement with isoflurane and/or fentanyl (maximum dose <10 microgram/kg) as required. Increments of cisatracurium (0.03 mg/kg) were administered every 30 minutes and before coming on cardiopulmonary bypass (0.1 mg/kg). During CPB, propofol was infused intravenously 5 mg/kg/hour until coming off the CPB.

A conventional cardiac surgical technique was used in all procedures, beginning with a median sternotomy to allow the precision achieved through maximal exposure and access. With the cardiopulmonary bypass, we used moderate systemic hypothermia and antegrade cardioplegia for cardiac arrest to accomplish a stationary and bloodless field while using optimal strategies of myocardial protection. After surgery, all patients were managed by the same clinician and nursing care team at the pediatric intensive care unit. Following the operation, "early extubation" was defined as extubation occurring within 4 hours postoperatively.

Positive indicators for extubation were:

1. Hemodynamic stability (no or decreasing use of cardioactive drugs, systolic blood pressure >90 mmHg)
2. Absence of significant bleeding (<5 mL/kg/hr)
3. Absence of significant arrhythmias
4. Adequate urine output (>1 mL/kg/hr)
5. Oxygen saturation more than 95% with fractional concentration of inspired oxygen less than 0.5
6. The patient was sufficiently awake to follow commands
7. PaCO₂ < 50 mmHg, and PaO₂ > 70 mmHg with FiO₂ < 0.5 if possible

Contraindications for discharge from ICU (postoperative day 0–1) after extubation were:

1. Any increasing requirement for cardioactive drugs
2. Significant decrease in oxygen saturation (<90% despite oxygen mask)
3. Urine output or level of consciousness decreased
4. Severe unsuspected cardiac arrhythmia (supraventricular and ventricular arrhythmia).

Hospital discharge criteria:

1. Stable hemodynamics
2. Adequate mental status
3. Ability to ambulate and eat
4. Afebrile status
5. Adequate family or social support system.
Statistical analysis was performed using the student’s t-test and χ² as appropriate. A p-value of <0.05 was considered statistically significant. The statistical analyses were carried out using the STATA statistical package (Version 6.0; College Station, TX).

Results

Preoperative and operative data

Table 1 shows the demographic data, diagnosis with cardiac history, and operative data. The patients’ demographic, biological, and operative data were similar in both groups. There were no significant differences in age, gender, height, or weight between the EE and NEE groups. The duration of CPB, aortic cross-clamp time, and total operative times were also similar in both groups.

Outcome data

Table 2 shows the major outcome data of the study. Average postoperative ventilator time was 1.77 ± 1.31 hours in the EE group and 25.82 ± 40.44 hours in the NEE group (p < 0.05). Use of blood components (red cells) averaged 1 unit per patient in both groups. A low dose of an inotropic drug (dopamine 3–5 µg/kg/min) was used to maintain hemodynamic stability in both groups. There were no significant differences in the ICU or hospital stay between the EE and NEE groups. Only one patient of this study died (EE group), but the death was not related to the extubation period (a sudden death on day 3 postoperatively due to cardiac arrhythmia).

Table 1 Comparison of demographic data, diagnosis with cardiac history and operative data between early extubation (EE) (N = 27) and non-early extubation (NEE) (N = 29) patients

<table>
<thead>
<tr>
<th></th>
<th>EE</th>
<th>NEE</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic data (Mean ± SD)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>7.11 ± 3.02</td>
<td>8.34 ± 4.75</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>Sex (male: female)</td>
<td>11:16</td>
<td>16:13</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>113.11 ± 30.16</td>
<td>103.24 ± 50.08</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>24.86 ± 24.88</td>
<td>20.29 ± 13.76</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td><strong>Diagnosis (case)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASD*</td>
<td>14</td>
<td>10</td>
<td>–</td>
</tr>
<tr>
<td>VSD**</td>
<td>11</td>
<td>15</td>
<td>–</td>
</tr>
<tr>
<td>Other***</td>
<td>2</td>
<td>4</td>
<td>–</td>
</tr>
<tr>
<td><strong>Operative data (Mean ± SD)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total operative time (min)</td>
<td>223.89 ± 41.4</td>
<td>218.79 ± 54.44</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>Cardiopulmonary bypass time (min)</td>
<td>61.07 ± 48.45</td>
<td>69.00 ± 31.49</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>Aortic cross-clamp time (min)</td>
<td>41.96 ± 30.40</td>
<td>44.59 ± 25.35</td>
<td>P &gt; 0.05</td>
</tr>
</tbody>
</table>

* Atrial septal defect ** Ventricular septal defect ***VSD/or ASD with ductus arteriosus

Table 2 Comparison of the postoperative variables between early extubation and non-early extubation patients

<table>
<thead>
<tr>
<th></th>
<th>EE</th>
<th>NEE</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilator time (hours)</td>
<td>Mean (SD)</td>
<td>1.77 ± 1.31</td>
<td>25.82 ± 40.44</td>
</tr>
<tr>
<td>ICU stay (days)</td>
<td>Mean (SD)</td>
<td>1.22 ± 0.69</td>
<td>1.58 ± 1.45</td>
</tr>
<tr>
<td>Postoperative hospital stay (days)</td>
<td>Mean (SD)</td>
<td>5.92 ± 2.26</td>
<td>7.34 ± 3.74</td>
</tr>
<tr>
<td>30–day mortality rate</td>
<td>n (%)</td>
<td>1 (3.7%)</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 3 shows postoperative complications. There were no postoperative complications in the EE group but 4 patients (13%) of patients in the NEE group had complications. One patient (3.4%) in the NEE group required reintubation after he developed hypoxemia.

Table 3  Comparison of the complications between early extubation and non–early extubation groups

<table>
<thead>
<tr>
<th>Complication</th>
<th>EE</th>
<th>NEE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Reoperation</td>
<td>0</td>
<td>1 (3.4%)</td>
</tr>
<tr>
<td>Reintubation</td>
<td>0</td>
<td>1 (3.4%)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>0</td>
<td>3 (10.3%)</td>
</tr>
<tr>
<td>Low cardiac output</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pleural effusion</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Discussion

Routine overnight postoperative ventilation following cardiac surgery was adopted in the 1960s after the frequent postoperative respiratory complications in open heart surgical patients. The increasing number of congenital heart patients undergoing cardiac operations under cardiopulmonary bypass and the limited resources for postoperative intensive care have stimulated attempts to reduce the length of stay of these patients in high–cost units. Recently there has been much interest in early extubation or fast–track management following cardiac surgery.

The concept of "early extubation" is not well–defined in the literature, referring to a range of times from extubation in the operating room just after the operation to extubation at any time before the morning after surgery. Intraoperative extubation in adult cardiac surgery has been proposed as a means of further reducing or eliminating an ICU stay. However, almost all of our pediatric patients underwent extubation at the ICU and early extubation times were less than 4 hours. This practice does not seem to have affected the recovery subsequent to extubation or transfer from the ICU. An overnight ICU stay, along with full monitoring options, additionally allowed us to document cardiac, respiratory, and detailed hemodynamic stability, and in turn guide the discharge decisions. There was only one case in this study of death in the early extubation group (postoperative day 3) and this was not related to the extubation.

Previous studies have suggested that in comparison with adults, the pediatric myocardium might be more vulnerable to ischemia and reperfusion injury after operations using cardiopulmonary bypass, thereby justifying a slower approach to extubation and discharge in the pediatric patient. In the elective pediatric setting, we have seldom observed myocardial failure and no significant hemodynamic impairment in either group. Perioperative inotropic support and blood transfusions were minimized in this study. The early extubation process used in this study contributed to early ambulation and feeding, increasing the patient’s autonomy, and can also, by reducing the time of mechanical ventilation, reduce the medical and nursing postoperative workloads. Further potential benefits of early extubation include cost savings, lowered nursing dependency, reduced airway and lung trauma, improved cardiac output and renal perfusion with spontaneous respiration, and reduced stress and discomfort from endotracheal suctioning and weaning from ventilation. Our series shows only that early extubation does not result in a decreased ICU and hospital stay, without increased complications, so the obvious advantage of the early extubation in this issue needs further study. Numerous studies have shown that the early extubation is a safe and effective option for patients undergoing congenital cardiac surgery. Our research confirms that in selected patients undergoing congenital cardiac surgery, fast–track management can be performed successfully. Complications related to early extubation were low in our series, perhaps due to careful selection of patients, timing of operation, and the patients having only a simple congenital defect. Certain preoperative factors may define a high–risk subgroup, thereby allowing for the modification of their postoperative course. Pediatric congenital heart disease patients undergoing elective cardiac surgery is an excellent substrate for a fast–track protocol because the patients usually arrive at the operation in
stable condition with nothing more than medically managed heart failure, cyanosis, or nutritional support. Compared with adults undergoing cardiac surgery, the incidence of preoperative comorbidity is relatively minimal. The main drawback of the present small study was that patients were not randomly assigned to the study and control groups in a certain time period, which may have introduced some bias. However, such bias is considered to be negligible in the postoperative results and recovery period, because the preoperative profiles were similar in each group.

Conclusion

In conclusion, we have found that an early extubation (less than 4 hours) can be both effective and safe as it reduces intubation and ventilator times without increasing postoperative complications in pediatric congenital heart disease. Our study supports a wider use of fast-track extubation protocols in pediatric patients submitted for congenital cardiac surgery in developing countries, but these findings need to be confirmed through further randomized controlled studies.

References