

Fast-Track Extubation Experience in the Operating Room After Congenital Heart Surgery in Infants

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Abstract

Objectives: Early extubation applications after pediatric congenital heart surgery have increased in recent years because of the positive results of these studies. It remains controversial whether early extubation should be performed in the operating room or in the intensive care unit. In addition, there are differences between hospitals in early extubation practices after pediatric cardiac surgery. In this study, we aimed to contribute to the literature by presenting our first 12 cases of infants extubated in the operating room after congenital heart surgery.

Materials and Methods: Between May 2022 and December 2022, this study included the first 12 infant patients aged ≤ 1 year who underwent congenital heart surgery and were early extubated in the operating room.

Results: The cohort comprised 6 girls and 6 boys, with an 11-month-old male patient presenting with pulmonary hypertension. Seven patients underwent cardiopulmonary bypass, with temperatures set at 32 °C for 4 patients and 34 °C for 3 patients. No respiratory problems occurred in the patients. None of the infants required non-invasive ventilation. There was no need for reintubation in the early or late period.

Conclusion: Our findings suggest that a significant proportion of infant patients can be safely extubated in the operating room following congenital heart surgery. Early extubation offers the potential to decrease the need for sedation and inotropes, thereby averting complications associated with mechanical ventilation.

Keywords: Congenital heart defect, early extubation, operating room, infant



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Introduction

In recent years, the adoption of early extubation following pediatric congenital heart surgery has seen an upward trend due to encouraging study outcomes. This practice is also a pivotal element within the enhanced recovery after surgery protocols for pediatric cardiac surgery⁽¹⁾. The definition of early extubation has varied, ranging from extubation in the operating room up to 6 h postoperatively. In some cases, neonatal extubation within 24 h of the operation is considered early.

Nevertheless, the question persists regarding whether early extubation is best performed in the operating room or in the intensive care unit, and there are divergences in practices among hospitals. In multicenter studies, the rate of early extubation in the operating room exhibits considerable variation, ranging from 25% to 94%^(2,3).

Extubation in the operating room immediately after surgery is not a standardized procedure and is only undertaken in selected cardiac surgery centers. This study contributes to the existing literature by presenting our initial experience with 12 infants who underwent extubation in the operating room following congenital heart surgery.

Materials and Methods

Ethical approval was obtained from the Ethics Committee of University of Health Sciences Turkey, Dr. Behçet Uz Child Disease and Pediatric Surgery Training and Research Hospital (approval no: 108, date: 15.05.2023). This study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was obtained from all patients.

Between May 2022 and December 2022, this study included the first 12 infant patients aged ≤ 1 year who underwent congenital heart surgery and were early extubated in the operating room. The exclusion criteria were emergency surgery, preoperative inotrope administration, and preoperative intubation. Patient demographic data, details of the surgical intervention, duration of cardiopulmonary bypass (CPB), cross-clamp duration,

anesthesia duration, inotropic requirements, postoperative near-infrared spectroscopy (NIRS) values, and intensive care unit and hospital stays were meticulously recorded.

Anesthesia induction was achieved using ketamine, midazolam, fentanyl, rocuronium, and low-dose sevoflurane inhalation. The tidal volume was maintained at 8-10 mL/kg with end-tidal carbon dioxide monitoring. Central venous and arterial catheterization was performed. Bispectral index (Medtronic, Minneapolis, MN, USA) and near-infrared spectroscopy (INVOS; Medtronic, Minneapolis, MN, USA) monitoring were performed. The depth of anesthesia was adjusted according to BIS monitoring. At the end of the surgery, we used sugammadex to eliminate the effect of the muscle relaxant. Pethidine and acetaminophen were used to treat postoperative pain. We determined the following as early extubation criteria: normal metabolic picture, low lactate value, hemodynamic stability, normal oxygenation, normal NIRS value, not long CPB and cross-clamp time. After extubation, the patients were taken to intensive care with oxygen support via a mask. Mild sedation was provided with ultra-low-dose midazolam. Intravenous analgesics were administered for pain.

Results

All 12 patients were successfully extubated in the operating room immediately after surgery and were subsequently transferred to the intensive care unit. The cohort comprised 6 girls and 6 boys, with the 11-month-old male patient presenting with pulmonary hypertension. None of the patients exhibited signs of syndromic disease. Arterial and central catheters were inserted under ultrasound guidance for all patients, and NIRS and bispectral index monitoring were universally applied. Seven patients underwent CPB, with temperatures set at 32 °C for 4 patients and 34 °C for 3 patients. The demographic and surgical data of the patients are summarized in Table 1.

On the first postoperative day, patients were closely monitored in the intensive care unit before transitioning

Table 1. Demographic and operation data of infants

	Age	Gender	Weight	Operation	CPB time	Anesthesia time	Postop NIRS	ICU stay	Hospital stay
Case 1	1 years	Female	7.6 kg	ASD	62 min	195 min	90	1 day	8 days
Case 2	1 years	Female	10 kg	ASD	57 min	215 min	75	1 day	7 days
Case 3	1 years	Male	9.8 kg	ASD	44 min	180 min	72	1 day	4 days
Case 4	1 years	Male	12 kg	ASD+Pulmonary valvotomy	87 min	245 min	75	1 day	7 days
Case 5	11 months	Male	10 kg	VSD	91 min	270 min	78	2 days	11 days
Case 6	5 months	Female	5 kg	VSD+ASD	56 min	235 min	94	1 day	15 days
Case 7	5 months	Female	7 kg	VSD+Coronary AV fistula closure	95 min	220 min	70	1 day	6 days
Case 8	4 months	Male	4 kg	PDA	No	90 min	68	1 day	9 days
Case 9	2 months	Female	6 kg	PDA	No	115 min	70	1 day	4 days
Case 10	1 month	Male	5 kg	ACoA+PDA	No	165 min	75	1 day	12 days
Case 11	1 years	Female	8 kg	ACoA+PDA	No	150 min	71	1 day	8 days
Case 12	1 years	Male	9 kg	ACoA+Aortic arch plasty+PDA	No	200 min	92	1 day	7 days

ASD: Atrial septal defect, VSD: Ventricular septal defect, PDA: Patent ductus arteriosus, CPB: Cardiopulmonary bypass, NIRS: Near-infrared spectroscopy, ICU: Intensive care unit

to the ward. No intraoperative or postoperative inotropes were required, and there were no complications during the perioperative period. No respiratory problems occurred in the patients. None of the infants required non-invasive ventilation. There was no need for reintubation in the early or late period. Importantly, no instances of mortality were observed in either the intraoperative or postoperative periods.

Discussion

In particular, in infants, complex cardiac surgeries, prolonged CPB duration, and hemodynamic instability often result in extended mechanical ventilation periods. Prolonged mechanical ventilation poses a risk of complications associated with intubation, the presence of an endotracheal tube, ventilator-induced lung injury, and oxygen-related infectious complications.

Fast-track anesthesia has been used for the last 30 years as a procedure that allows extubation in the first 6 h after cardiac surgery^(4,5). Ultrafast track anesthesia has been used for the last 20 years and is the method of extubations performed in the operating room or up to 1 h after cardiac

surgery⁽⁶⁾. Ultrafast-track anesthesia application shortens extubation time, intensive care unit stay, and hospital stay in children undergoing cardiac surgery⁽⁴⁾.

In fast-track anesthesia, it is important to use short-acting or low-dose medication for early extubation. The intraoperative use of opioids under anesthesia may influence extubation or the duration of mechanical ventilation. Respiratory depressant effects of these drugs in infants could lead to extubation failure within the first 24 h postoperatively⁽⁷⁾. Amula et al.⁽⁸⁾ demonstrated that reducing the intraoperative opioid dose in infant cardiac surgery correlated with an increased rate of early extubation.

Postoperative extubation in the operating room is not a standard procedure and is performed only in a limited number of cardiac surgery centers⁽⁹⁾. Because the patient population in pediatric cardiac surgery is very heterogeneous, the experience of early extubation is less well defined. Early extubation results in a lower postoperative inotrope score, a shorter duration of catecholamine therapy, a decrease in ventilator-related complications, and a decrease in the hospital costs^(4,9-12).

Studies have indicated that fast-track extubation can be safely implemented in infants undergoing open heart surgery, leading to reduced intensive care and hospital stays, diminished inotropic support, and fewer postoperative transfusions⁽¹³⁾. The positive effects of early extubation in infants undergoing cardiac surgery extend to cost reduction, manifesting as decreased drug costs-especially those associated with respiratory care and mechanical ventilation-laboratory and imaging procedures, sedation, and analgesia⁽¹⁴⁾.

Pediatric patients who have undergone cardiac surgery and are extubate may need reintubation. In a multicenter study, this rate was found to be 6% in patients extubate in the operating room and 10% in patients extubate in the intensive care unit⁽³⁾. Risk factors for reintubation after pediatric cardiac surgery include age, genetic disorders, complex surgery, the need for reoperation, developing complications (acute lung injury, chylothorax, diaphragm paralysis, seizure, and sepsis), hemodynamic instability, and upper airway obstruction^(3,15).

Conclusion

Our findings suggest that a significant proportion of infant patients can be safely extubate in the operating room following congenital heart surgery. Early extubation offers the potential to decrease the need for sedation and inotropes, thereby averting complications associated with mechanical ventilation. Furthermore, cost reduction can be achieved by shortening the ICU stay through early nutrition and mobilization. The success of early extubation in the operating room hinges on the collaborative efforts of pediatric cardiac surgeons, anesthesiologists, and intensive care specialists that contribute to the fast-track strategy.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the Ethics Committee of University of Health Sciences Turkey, Dr. Behçet Uz Child Disease and Pediatric Surgery Training and Research Hospital (approval no.: 108, date: 15.05.2023).

Informed Consent: Informed consent was obtained from all patients.

Authorship Contributions

Surgical and Medical Practices: Karaçelik M, Bilen Ç, Concept: Salman Önemli C, Evren Şahin K, Design: Salman Önemli C, Data Collection and/or Processing: Salman Önemli C, Karaçelik Ç, Analysis and/or Interpretation: Karaçelik M, Bilen Ç, Literature Search: Salman Önemli C, Evren Şahin K, Writing: Salman Önemli C, Karaçelik M.

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