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Ultra-Fast-Track Extubation Experience in Pediatric Cardiac Surgery

Pediyatrik Kalp Cerrahisinde Ultra-Fast-Track Ekstübasyon Deneyimlerimiz

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ABSTRACT

Objectives: The efficacy and safety of early extubation after pediatric congenital heart surgery was evaluated.

Methods: Thirty-two patients who underwent pediatric cardiac surgery between 2014 and 2015 were included in the study. Diagnosis of the patients: atrial septal defect (eight patients), ventricular septal defect (seven patients), Fontan procedure (four patients), cavapulmonary anastomosis (six patients), Fallot tetralogy (four patients), abnormal left coronary artery originating from pulmonary artery (two patients), and dual outlet right ventricle was one patient. The duration of cardiopulmonary bypass, cross clamp, extubation, reintubation, and intensive care unit stay of the patients was recorded.

Results: The patients were extubated in the operating room (ultra-fast-track extubation) after surgery. One patient required reintubation after 2 h.

Conclusion: In ultra-fast-track extubation approaches for pediatric cardiac surgery patients, careful pre-operative evaluation, perioperative management, and patient selection together with the characteristics of the cases are very important. In our study, it was observed that early extubation could be performed safely.

Keywords: Extubation; fast-track; pediatric cardiac surgery.

ÖZET

Amaç: Çalışmada, pediyatrik konjenital kalp cerrahisi sonrası erken ekstübasyonun etkinliği ve güvenirliği değerlendirildi.

Yöntem: 2014-2015 yılları arasında pediyatrik kalp cerrahisi uygulanan 32 hasta çalışmaya alındı. Hastaların tanıları: atriyal septal defekt (sekiz hasta), ventriküler septal defekt (yedi hasta), fontan prosedürü (dört hasta), kava pulmoner anastomoz (altı hasta), fallot tetralojisi (dört hasta), pulmoner arterden kaynaklanan anormal sol koroner arter (iki hasta) ve çift çıkışlı sağ ventrikül (bir hasta) şeklindeydi. Hastaların kardiyopulmoner baypas, kros klemp, ekstübasyon, reentübasyon ve yoğun bakımda kalış süreleri kaydedildi.

Bulgular: Hastalar cerrahi sonrası ameliyathanede (ultra-fast-track ekstübasyon) ekstübe edildi. Bir hastada iki saat sonra yeniden entübasyon gerekti.

Sonuç: Pediyatrik kalp cerrahisi hastaları için ultra-fast-track ekstübasyon yaklaşımlarında, dikkatli preoperatif değerlendirme, perioperatif yönetim, olguların özelliği ile birlikte hasta seçimi oldukça önemlidir. Çalışmamızda erken ekstübasyonun güvenli bir şekilde yapılabildiği görüldü.

Anahtar sözcükler: Fast-track; ekstübasyon; pediyatrik kalp cerrahisi.

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Nowadays, shorter post-operative mechanical ventilatory support times are possible due to the improved surgical techniques and new anesthetic drugs with shorter half-time. For this reason, fast-track anesthesia techniques are in use. Early extubation is an important factor that could decrease stay of hospital and intensive care unit (ICU).[1] Extubation in post-opera-

tive 6 h is defined as fast-track extubation, if it is completed in operation room (OR), current term is ultra-fast-track extubation. Positive pressure ventilation has detrimental effect on congenital pediatric cardiac patients, especially who have single ventricle physiology, and to resolve that this negative effect is crucial.[2,3] Many studies have shown that extubation in OR is advantageous for patients with Fontan circulation.[4,5] We have evaluated the results of our ultra-fast-track extubation experience on pediatric patients after cardiac surgery.

Methods

After having permission of hospital committee of educational planning and coordination and written consent of the parents, data of the pediatric patients that have been performed cardiac surgery and extubated early after operation are collected retrospectively. The patient groups which are excluded and not performed early extubation are with severe pulmonary hypertension, pre-operative pulmonary dysfunction, anatomically difficult airway, delayed sternal closure, bleeding diathesis, genetical anomaly, left ventricular failure detected in intraoperative transesophageal echocardiography, body mass under 4000 g, and with infantile age. Preoperatively, 0.5 mg/kg midazolam (Dormicum amp, Deva) is orally administrated for all patients.

Patients are routinely monitorized with ECG, SpO2 (pulse oximeter), cerebral oxygenation NIRS (near infrared spectroscopy, CAS Medical Systems Inc., Branford, Connecticut, USA) in OR. After insertion of peripheral venous catheter, induction of anesthesia is performed using, 0.1 mg/kg dormicum, 0.5 mcg/kg fentanyl (Talinat amp,Vem Pharmaceuticals), and ve 1 mg/kg rocuronium (esmeron, MSD).

Ventilatory settings, fraction of inspired oxygen (FiO2), and tidal volume (6 mL/kg) are set according to the type of cardiac pathology and respiratory rate is adjusted considering ages and weights of the patients. Then, catheterization of radial artery and internal jugulary vein (4–5 F, Plastimed, France) is performed. Anesthesia is maintained by infusion of 2 mcg/kg/h fentanyl, 2% sevoflurane 0.15 mg/kg rocuronium, and without loading dose 1 mcg/kg saat dexmedetomidine.

At the end of the operation, mixture of 0.5% ropivacaine and 0.9% NaCl 0.08 mL/kg are injected into parasternal intercostal area after sternal closure. In addition, 20 mg/kg acetaminophen and 3 mg/kg theophylline ethylenediamine are administrated through intravenous (IV) route. Care is given that extubation criteria's such as normothermia, hemodynamic stability, and absence of mediastinal bleeding were met. After cessation of anesthetic drugs, neostigmine 0.07 mg/kg ve atropine 0.02 mg/kg was given on evaluating the spontaneous ventilation of the patients. After a brief observation on spontaneous ventilation, arterial blood gase results were controlled. Patients with sufficient muscle tone and tidal volume (>5 mL/kg) were extubated under sedation and followed with 2–4 L/kg O_2 inhalation through mask, in OR.

After confirmation of hemodynamic and respirational stability, patients were transferred to ICU. Duration of cross-clamp, cardiopulmonary bypass (CPB), and length of stay at ICU, and numbers of reintubation requirements were collected.

In analysis of results, SPSS (Statistical Package for the Social Sciences) for Windows 10.0 was used for statistical analysis. Results are evaluated with 95 % confidence interval, and threshold for statistical significance is $p<0.05$.

Results

Thirty-two of the patients who were undergone pediatric cardiac surgery were extubated in OR. Distribution of patients according to pathologies was as follows; atrial septal defect n:8 (%25), ventricular septal defect n:7 (21.8%), Fontan procedure n:4 (12.5%), cavapulmonary anatomosis n:6 (18.7%), Tetralogy of Fallot n:4 (12.5%), anomalous left coronary artery from the pulmonary artery n:2 (6.25%), and DORV (double outlet right ventricle) n:1 (3.1%) (Table 1).

Table 1. Distribution of patients according to their diagnoses

Diagnoses	n (Mean±SD) %
ASD	8 (25)
VSD	7 (21,8)
FONTAN Procedure	4 (12.5)
CPA	6 (18,7)
TOF	4 (12.5)
ALCAPA	2 (6.25)
DORV	1 (3.1)
Total	32

ASD: Atrial septal defect; VSD: Ventricular septal defect; CPA: Cavapulmonary anastomosis; TOF: Tetralogy of fallot; ALCAPA: Anomalous left coronary artery from the pulmonary artery; DORV: Double outlet right ventricle.

Patient's characteristics were according to age 4 to 144 months (47.2±5.8), gender; female 13 (40,6 %) and male 19 (59.3%), weights 5.5–36 kg (15.3±3.4).

Duration of CPB was 38–122 min. (66.2±10.8), while cross-clamp duration was 20–102 min.(48±9.8) RACSH (Risk adjustment for congenital heart surgery) score was between 1 and 3 (2.06±0.8). Mean length of ICU stay, for extubated patients, was 1–7 days (2.5±0.9). One patient was reintubated due to excessive airway secretion (3.3%). One patient died 36 h after extubation in consequence of hemodynamic problem (3.3%) (Table 2).

Discussion

The term of fast-track anesthesia based on early extubation has been used due to improvements of short-acting anesthetic drugs and technical developments in pediatric heart surgery.[6-8] Studies showed reduced length of stay and treatment costs without increase of mortality or morbidity. Pediatric patient population show differences due to the pathologies of physiological and anatomical complexity. Hence, there is not any standard method, management of anesthesia and extubation process depends on cardiac pathology.

Selected patient populations have a chance for early extubation. Early extubation decreases post-operative pulmonary tract infections, ensures minimal use of anesthetic and sedative drugs, and also reduces the incidence of hemodynamic instability when awaking under mechanical ventilation, pulmonary hypertensive crisis, increasement of intrathoracic, and intrapulmonary artery pressure.[8]

Of the patients who were extubated in OR according to ultra-fast-track extubation protocol, length of stay in ICU, and mortality rate were assessed.

Table 2. Characteristics of the patients

Age (month)	47.2±5.8 month
Sex(F/M)	13(40,6%)/19(59,3%)
Weight (kg)	15.3±3.4
CPB duration (min)	66.2±10.8
Cross clamp time (min)	48±9.8
RACSH score	2.06±0.8
Reintubation (%)	1 (3.3%)
Intensive care stay (days)	2.5±0.9
Exitus (day)	1 (3.3%)

CPB: Cardiopulmonary bypass, RASCH score: Risk adjustment for surgery for congenital heart disease.

Early extubation has been first described by Barash et al.[8] in 1980. In the study of 197 patients, 142 patients were extubated, five patients (4%) were reintubated. In our patient population, reintubation rate was 3.3%. Many studies claim that ultra-fast-track extubation is easier to accomplish on older children, infants, and neonates that have shown more problematic extubation course in OR. Infants especially under 1 month have higher reintubation rates.[9-12]

In a study of Hamilton et al.,[10] 50 patients were extubated in OR, RACSH score was 2.33, aortic cross clamp time was 36.26 min, and CPB duration was 66.88 min. Our patient group has RACSH score of 2.06, cross clamp time was 48±9.8 min, CPB duration was 66.2±10.8 min, and average length of stay in ICU was 1.9 days.

Miller et al.[12] state the importance of over 4 kg of weight, surgical procedures with less complexity, and absence of genetic anomalies such as trisomy 21 for a successful extubation.

In our study, several contributing factors such as appropriate age and weight of the extubated patients, lower RACSH scores, and performing a successful surgery without complication have a favorable effect on results. Kin et al.[9] emphasize that lower weight, longer CPB time, hypothermic arrest period, pulmonary hypertension, and the need for high dose inotropic agents are detrimental factors for early extubation.

Advantages of early extubation have been shown on ICU period especially for single ventricle patients. In single ventricle psychology, especially with Fontan procedure, pulmonary artery has a passive blood flow; therefore, it is advised to accomplish an early extubation to minimize the negative effects of positive pressure ventilation.[2,3] In the study of Kawaguchi et al.,[2] 75 patients with single ventricle physiology were extubated. Of these patients, 8 (10,6 %) were reintubated.

Mortality rate was found 4% in the study of Preisman et al.[11] In the study, we present one patient died due to cardiac origin and mortality rate was similar (3.3%). Studies should enlighten the reason of mortality, if it was caused by early extubation or other factors.

Reintubation rate was 6.2% (Preisman et al.). In other study of 197 pediatric patients, 142 were extubated in OR and 4% of them were reintubated (Barash et al.).[8] One was died due to pulmonary complications. Results of Vricella et al.,[13] 175

patients were extubated in the OR and four patient (2%) were reintubated, and mean length of stay in ICU was 2 days.

Conclusion

It is difficult to separate the pediatric patients underwent cardiac surgery into homogenous groups of pathologies. Most patients have been through multiple operations and have comorbidities. For patients with single ventricle defect (Fontan procedure and cavopulmonary anastomosis), early extubation provides benefits for post-operative prognosis. And yet, it is challenging to define a standard early extubation procedure. Thus, we believe that patients should be evaluated with all the parameters and contributing factors and selective approach is needed for desirable results when deciding for the early extubation.

Disclosures

Ethics Committee Approval: Dr.Siyami Ersek Training and Research Hospital Scientific Committee. E-28001928-604-01-01 Date: 13/09/2021.

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