The Egyptian Cardiothoracic Surgeon

Vol. 3, No. 1, 22 - 27

Original Article

Ultrafast-track extubation after pediatric cardiac surgery; benefits and safety

Mohamed Elgazzar[1], Mohamed Abdelrahman[2], Amany Khedr[2], Basem Abdelgawad[1]

[1] Department of Cardiothoracic surgery, Faculty of Medicine, Benha University, Qalyobia, Egypt

[2] Department of Anesthesia and Intensive Care, Faculty of Medicine, Benha University, Qalyobia, Egypt

Abstract

Background: Ultrafast-track extubation after cardiac surgery my facilitate rapid recovery. However, the overall risk-benefit is still debatable. The objective of this study was to report the effect of ultrafast-track extubation in pediatric patients undergoing cardiac surgery.

Methods: This is a retrospective study that included 260 patients who had surgery for congenital heart diseases between 2015 and 2019. Patients were divided into two groups. Group A included patients who had ultrafast-track extubation protocol (n = 140), and group B was the conventional anesthesia group (n = 120).

Results: The mean age was 3.68 ± 2.1 and 3.8 ± 1.6 years for groups A and B, respectively (p= 0.08). The total operative time was higher in group A (326± 18.15 vs. 274.6±28.1 minutes; p <0.001), and the degree of pulmonary hypertension were higher in group B (p= 0.02). The rate of ventilator-related complications was higher in group B (P = 0.02). There was a significant reduction in mean length of intensive care unit stay between the ultrafast-track extubation and the conventional groups (65.3 ± 33.7 and 81.6±70.2 hours, respectively; p= 0.001). The total hospital stay was significantly reduced in group A (6.7 ± 2.7 vs. o 7.43±2.65 days for group A and B, respectively, p= 0.03).

Conclusions: The application of ultrafast-track extubation protocol could lead to a reduction in the ventilator-related complications, the length of intensive care unit and hospital stays without increasing postoperative complications.

KEYWORDS
Ultrafast-track extubation; On-table extubation; Fast-track anesthesia; Early extubation after cardiac surgery

Article History
Submitted: 1 July 2020
Revised: 23 July 2020
Accepted: 26 Aug 2020
Published: 1 Jan 2021

Introduction

Ultrafast-track extubation (UFTE) is defined as the extubation of cardiac surgery patients in the operating room (OR) or within two hours after arrival to the intensive care unit (ICU). UFTE requires careful selection of cases, a special protocol for anesthesia, and cooperation between the team members to get the best outcome [1,2].

Mechanical ventilation impairs venous return, lowers cardiac preload, and decreases cardiac output, thus potentially prolongs ICU stay. Moreover, tachycardia and hypertension are other responses to mechanical ventilation that necessitate treatment, and if narcotic sedation is utilized as treatment, it will increase intubation time and length of stay [3]. Prolonged ventilation could lead to laryngeo-tracheal trauma, induce pul¬monary hypertensive crisis during tracheal suction, and atelectasis [4].

Early extubation has potential benefits, including early mobilization, shorter ICU and hospital stays, and improved patient satisfaction. Furthermore, early extubation has been shown to hasten the return of respiratory ciliary function,

Corresponding author: Basem Abdelgawad bassem.abdelgawad@fmed.bu.edu.eg

improve respiratory dynamics, thereby decreasing atelectasis and ventilator-associated pneumonia (VAP). Besides, respiratory physiotherapy will be commenced early to reduce com¬plications. Furthermore, early extubation decreases lung resistance and improves cardiac compliance and overall cardiac performance [3].

Early extubation further decreases resource utilization. Moreover, patients will be stable enough to be transferred earlier to a lower dependency unit, with fewer nursing staff requested to manage each patient [5]. On the other hand, ultrafast-track extubation may increase respiratory and cardiac workload, causing low cardiac output (LCOP), hypothermia, shivering, inability to give adequate doses of analgesia, and re-intubation. Furthermore, mediastinal bleeding requiring re-exploration is a poten¬tial problem in cardiac surgery wherein a secured airway is desired [6].

The potential advantages of UFTE in pediatric cardiac surgery have not been fully established. The objective of this study was to report the effect of ultrafast-track extubation in pediatric patients undergoing cardiac surgery.

Patients and Methods:

Patients and design:

We performed a retrospective study, including 260 patients who had cardiac surgery between January 2015 and January 2019 by the same anesthesia and cardiac surgery team. Patients were divided into two groups according to the applications of UFTE protocol. Group A included patients who successfully received the UFTE protocol for anesthesia (n= 140), and group B had the conventional anesthesia protocol (n = 120). Ultrafast-track extubation (UFTE) was defined as the extubation of the patients in the operating room (OR) or within two hours after arrival to the ICU. We included patients of 1st and 2nd categories of Risk Adjustment for Congenital Heart Surgery-1 (RACHS-1) score system of complexity [7]. Patients with complex cardiac disease, weight less than 7 kgs, and redo cases were excluded from the study.

Table 1: Comparison of the preoperative data between both groups. Continuous variables are presented as mean and SD and categorical variables as number and percentage.

	Group A (n= 140)	Group B (n= 120)	p
Male	82 (58.6%)	73 (60.8%)	0.12
Age (years)	3.68 ± 2.1	3.8 ± 1.6	0.08
Bodyweight (Kg)	15.46 ± 7.26	16.1 ± 5.7	0.13
Preoperative pathology			
ASD	25 (17.8%)	18 (15%)	
VSD	38 (27.1%)	39 (32.5%)	
SAM	11 (7.8%)	7 (5.8%)	
TOF	17 (12.1%)	18 (15%)	
Valvular PS	5 (3.6%)	3 (2.5%)	0.13
PAVC	15 (10.7%)	10 (8.3%)	
CAVC	10 (7.1%)	13 (10.8%)	
A commissurotomy	6 (4.3%)	4 (3.3%)	
BDG	13 (9.3%)	8 (6.7%)	
Pulmonary hypertension			
No	62 (44.3%)	36 (30%)	
Mild	53 (37.9%)	47 (39.2%)	0.02
Moderate	21 (15%)	30 (25%)	
Severe	4 (2.9%)	7 (5.8%)	

ASD: Atrial septal defect; VSD: Ventricular septal defect; SAM: Subaortic membrane; TOF: Tetralogy of Fallot; PS: Pulmonary stenosis; PAVC: Partial atrioventricular canal; CAVC: Complete atrioventricular canal; A Commissurotomy: Aortic commissurotomy; BDG: Bidirectional Glenn

Table 2: Comparison of the operative and postoperative data. Continuous variables are presented as mean and SD and categorical variables as number and percentage

	Group A (n= 140)	Group B (n= 120)	p
Operative time (min)	326± 18.15	274.6±28.1	<0.001
CPB time (min)	64.2±19.3	67.75±18.64	0.73
Ischemic time (min)	41.3±17.2	42.53±19.57	0.82
Arrhythmia	6 (4.3%)	4 (3.3%)	
LCOP	6 (4.3%)	5 (4.2%)	0.73
Disturbed consciousness	3 (2.1%)	2 (1.7%)	

CPB**:** cardiopulmonary bypass; LCOP: Low cardiac output

Furthermore, patients of group A who failed to be extubated on-table or within two hours in the ICU were also excluded. The study was approved by the local Ethical Committee, and the patients' consent was waived.

Anesthesia protocol:

All patients were given intravenous midazolam (0.1 mg/kg) before surgery as a pre-medication. Induction was achieved using midazolam (0.1 mg/kg), fentanyl (5 ug/kg), and pancuronium (0.2 mg/kg). Maintenance of anesthesia was achieved using sevoflurane (3% in oxygen), and a continuous intravenous infusion of fentanyl (5 ug/kg/h). During cardiopulmonary bypass (CPB), the temperature was kept above 35 degrees centigrade. Fluid balance was targeted to be negative, we have used the least allowed priming volume and replaced crystalloids with colloids whenever possible, and hemofilter was used in patients less than 10 kgs. Postoperatively, all patients received intravenous morphine infusion (10-20 ug/kg/h), intravenous morphine bolus (0.1 mg/kg) on-demand, and intravenous paracetamol (15 mg/kg) every 6 hours.

Statistical analysis:

Data interpretation and statistical analysis were performed using the SPSS version.25 (IBM, Armonk, New York, United States). Comparisons between the two groups were performed using the independent t-test for numerical data. Categorical data were compared using the Chi-square or Fisher exact test when appropriate. P values less than 0.05 were considered significant.

Results

There was no statistically significant difference between groups A and B regarding gender, age, and body weight (p= 0.12, 0.08, and 0.13, respectively). Although there was no significant difference between both groups regarding the type of pathology (p= 0.13), there was a significant difference in the degree of preoperative pulmonary arterial hypertension (p= 0.03) (Table 1).

During surgery, there was a significant difference between groups A and B in total operative time, but there was no significant difference regarding cardiopulmonary bypass (CPB) or ischemic time, as shown in Table 2. There was no significant difference between groups A and B regarding postoperative cardiac and neurological complications (p = 0.73).

There was a significant difference between both groups in the rate of ventilator-related complications (p= 0.02). The mean time of ICU and hospital stay was significantly higher in group B. There was no significant difference in the rate of ICU readmission or mortality between both groups, as shown in Table 3.

Discussion

In our study, the mean age was 3.68 ± 2.1 and 3.8 ± 1.6 years for groups A and B, respectively, without significant difference. This age is considered older than most of that reported by many authors. Kanchi and coworkers studied a younger age group with a mean age of 32 ± 31 days and reported that 11% of UFTE patients required re-intubation and re-institution of mechanical ventilation [8]. In an observational study of 448 patients, the authors concluded that weight <5 kg, age <1 year, and cardiopulmonary bypass time >120 minutes were significant factors affecting extubation in the OR [9]. Nelson and

Table 3: ICU and hospital outcomes. Continuous variables are presented as mean and SD and categorical variables as number and percentage

	Group A (n= 140)	Group B (n= 120)	P
Ventilator complications			
Tube blockage	0	1 (0.8%)	0.02
CO2 retention	1 (0.8%)	2 (1.7%)	
Self-extubation	0	2 (1.7%)	
Pneumonia	1 (0.8%)	3 (2.5%)	
Pneumothorax	1 (0.8%)	2 (1.7%)	
Lobar collapse	2 (1.7%)	3 (3.4%)	
ICU stay (Hours)	65.3 ± 33.7	81.6 ± 70.2	0.001
Hospital stay (days)	6.7 ± 2.7	7.43 ± 2.65	0.03
ICU readmission	3 (2.1%)	2 (1.7%)	0.12
Mortality	3 (2.1%)	2 (1.7%)	0.12

colleagues reported delayed recovery from anesthesia, a higher rate of upper airway spasm, and more common arrhythmias when patients were younger and weighed less [10].

Regarding the preoperative diagnosis, the type of pathology was not significantly different between both groups as we have included patients of 1st and 2nd categories of Risk Adjustment for Congenital Heart Surgery-1 (RACHS-1) score system of complexity [7]. However, there was a significant statistical difference between both groups as regards the degree of preoperative pulmonary hypertension (P=0.03). These findings were similar to those of Davis and colleagues who reported that preoperative pulmonary hypertension was one of the major risk factors for failure of extubation in the OR [11]. Furthermore, another study by the same authors found that pulmonary hypertension was a risk factor for re-intubation in the ICU within 24 hours [12].

The total operative time was significantly higher in the UFTE group (p<0.001). This was related to the time needed for patient recovery from anesthesia and assuring successful weaning among cases extubated on-table. We have considered this delay as a drawback of UFTE as it has affected the OR turnover and delayed the second turn putting some patients at the risk of operating upon by less than the full human resources.

The cardiopulmonary bypass and ischemic time were not significantly different between the two groups. Many studies have reported a high failure rate of UFTE in surgeries exceeding a CPB time of 120 minutes [9,10,13].

The rate of development of postoperative complications like arrhythmia, LCOP, and disturbed consciousness was not affected by early extubation and was not significant between both groups (P=0.73). Harris and colleagues reported that patients in the early extubation group were less likely to develop postoperative complications [14]. Furthermore, some authors reported that very early extubation of patients after pediatric cardiac surgery does not produce cardio-depressive effects [15]. Many risk factors, rather than early extubation, contributed to postoperative arrhythmias such as younger patient age, longer cross-clamp time, and increased operative complexity [10].

The pulmonary complications were significantly higher in the conventional group. These results were supported by previous studies that have excluded infants <6 months old because smaller infants have weaker respiratory mechanics and require more ventilatory support post-cardiac surgery [16,17]. A meta-analysis of nine similar studies and a study of Xu and colleagues conducted on 194 patients with a mean age of 1.2 ± 0.5 for the UFTE group and having comparable pathology to our patients have reported a lower rate of ventilator-related complications and less need for re-intubation [18,19]. Moreover, the benefits of early versus delayed extubation were obvious in many studies conducted on a younger age group and having more complex pathology. Harris and colleagues concluded that early extubation was associated with a lower rate of re-intubation (4%vs 23%, P<0.001) compared with delayed extubation [14].

One of the valuable benefits of UFTE is the psychological satisfaction of parents and the ICU staff. Parents and most of the team members often view intubation and mechanical ventilation as an index of the severity of the child's condition following such kind of surgeries and prefer to have the child extubated as early as possible [8]. From the scientific point of view, no argument that patients extubation removes part of the cardio-respiratory support and subsequently means that their condition is more stable with confirmed neurological recovery without any feared cerebrovascular events. All these aspects psychologically satisfy the whole team.

Implementation of UFTE strategy was associated with shorter lengths of ICU stay (65.3 ± 33.7 hours) versus (81.6 ± 70.2 hours) for the delayed extubation strategy (p= 0.001). The hospital stays also were significantly shortened in group A versus group B (6.7 ± 2.7, and 7.43±2.65 days respectively, P=0.03). These findings were the most significant benefit of UFTE in many studies [14,18 – 20].

The hospital mortality was not significantly different between groups A and B with (p=0.12). Our finding was similar to many authors who supported the safety of on-table extubation [9]. However, other authors reported significantly lower mortality with early versus conventional extubation [14, 18].

Limitations

We did not monitor the depth of anesthesia. Surgeries for complex pathology and children below six months were excluded from the study. Pain and need for analgesia were not assessed after extubation. We have excluded patients who failed to have early extubation to avoid bias in comparison. The costs and resource utilization were not calculated.

Conclusion

The application of ultrafast-track extubation protocol could lead to a reduction in the ventilator-related complications, the length of intensive care unit and hospital stays without increasing postoperative complications.

Conflict of interest: Authors declare no conflict of interest.

References

1. Saad H, Salah M, Hosny H, Salah M. Ultra-Fast Track Cardiac Anesthesia: Risks, Benefits, and Predictors of Outcome. Med. J. Cairo Univ. 2015; 83 (2): 47-55.
2. Guller U, Anstrom KJ, Holman WL, Allman RM, Sansom M, Peterson ED. Outcomes of early extubation after bypass surgery in the elderly. Ann Thorac Surg. 2014; 77:781–800.
3. Bainbridge D, Cheng D. Current evidence on fast track cardiac recovery management. Eur Heart J Suppl. 2017; 19 (suppl A): A3–7.
4. Abdelwahab HH. Feasibility of ultrafast anaesthesia the first descriptive prospective study in Egypt. Egyptian J Cardiothorac Anesth. 2011; 3:643–651
5. Bainbridge D, Cheng DC. Early extubation and fast-track management of off-pump cardiac patients in the intensive care unit. Semin Cardiothorac Vasc Anesth. 2015; 19(2): 163–168.
6. Akhtar MI, Hamid M. Success and failure of fast track extubation in cardiac surgery patients of tertiary care hospital: one year audit. J Pak Med Assoc. 2009; 59(3): 154–156.
7. Jenkins KJ, Gauvreau K, Newburger JW, et al. Consensus-based method for risk adjustment for surgery for congenital heart disease. The Journal of Thoracic and Cardiovascular Surgery. 2002; 123 (1): 10-18.
8. Kanchi M. "Fast Tracking" Paediatric Cardiac Surgical Patients. Annals of Cardiac Anaesthesia. 2005; 8: 33-38.
9. Joshi RK, Aggarwal N, Agarwal M, Dinand V, Joshi R. Assessment of Risk Factors for a Sustainable "On-Table Extubation" Program in Pediatric Congenital Cardiac Surgery: 5-Year

Experience. Journal of Cardiothoracic and Vascular Anesthesia. 2016; 30 (6): 1530–1538.

10. Nelson JS, Vanja S, Maul TM, Jennifer K Whitham JK, Ferns SJ. Early arrhythmia burden in pediatric cardiac surgery fast-track candidates: Analysis of incidence and risk factors. Progress in Pediatric Cardiology. 2019; 52: 8-12.
11. Davis S, Worley S, Mee RB, Harrison AM. Factors associated with early extubation after cardiac surgery in young children. Pediatr Crit Care Med. 2004; 5:63-68.
12. Harrison AM, Cox AC, Davis S, Piedmonte M, Drummond-Webb JJ, Mee RB. Failed extubation after cardiac surgery in young children: Prevalence, pathogenesis, and risk factors. Pediatr Crit Care Med. 2002; 3: 148-152.
13. Akhtar MI, Hamid M, Minai F, et al. Safety profile of fast-track extubation in pediatric congenital heart disease surgery patients in a tertiary care hospital of a developing country: An observational prospective study. J Anaesthesiol Clin Pharmacol. 2014; 30(3): 355–359.
14. Harris KC, Holowachuk S, Pitfield S, et al. Should early extubation be the goal for children after congenital cardiac surgery? J Thorac Cardiovasc Surg. 2014; 148: 2642-8.
15. Meissner U, Scharf J, Dotsch J, Schroth M. Very early extubation after open heart surgery in children does not influence cardiac function. Pediatr Cardiol. 2008; 29 (2): 317–20.
16. Howard F, Brown KL, Garside V, Walker I, Elliott MJ. Fast-track paediatric cardiac surgery: the feasibility and benefits of a protocol for uncomplicated cases. Eur J Cardiothorac Surg. 2010; 37: 193-6.
17. Kurihara Y, Shime N, Miyazaki T, Hashimoto S, Tanaka Y. Clinical and hemodynamic factors associated with the outcome of early extubation attempts after right heart bypass surgery. Interact Cardiovasc Thorac Surg. 2009; 8: 624-8.
18. Alghamdi AA, Singh SK, Hamilton BC, et al. Early extubation after pediatric cardiac surgery: systematic review, meta-analysis, and evidence-based recommendations. J Card Surg. 2010; 25 (5): 586–95.
19. Xu J, Zhou G, Li Y, Li N. Benefits of ultra-fast-track anesthesia for children with congenital heart disease undergoing cardiac surgery. BMC Pediatrics. 2019; 19: 487.
20. Garg R, Rao S, John C, et al. Extubation in the operating room after cardiac surgery in children: a prospective observational study with multidisciplinary coordinated approach. J Cardiothorac Vasc Anesth. 2014;28(3):479–87.