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Early Extubation in Ventricular Septal Defect

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Abstract

Intoduction: The objective of the study to determine the feasibility of early extubation and to know the risk factors for delayed extubation in children who underwent closure of the VSD.

Materials and methods: The study was a prospective study done in a tertiary care university hospital. 87 consecutive patients undergoing VSD closure was included in the study. The interventions were to extubate as many patients as feasible within four hours after surgery.

Results: 68 of patients were extubated within 4 hours and 19 patients was extubated after 4hours. Mean duration of ventilation among male patients was 160.2 minutes and among female patients was 211.84 minutes. The mean age of the patient was 6.67 years. The mean weight of the patient was 16.85kg. The mean cardiopulmonary bypass time was 53.8 minutes. The mean cross clamp time was 30.11minutes. The mean duration of ventilation in mild PAH was 135.8minutes, moderate PAH was 190 minutes and severe PAH was 238.4minutes. The mean duration of ventilation in perimembranous VSD was 179.56 minutes, sub aortic VSD was 210 minutes and muscular VSD was 162.38 minutes.

Conclusions: Cardiopulmonary bypass time and aortic cross clamp time are the two factors which delay the early extubation. Age, weight, sex, severity of pulmonary artery hypertension and type of VSD did not affect early extubation.

Introduction

The desire to reduce hospital costs and the iatrogenic complications showed interest in clinical practice guidelines which included use of short acting anesthetic drugs, early extubation, reduced intensive therapy and hospital stay for pediatric patients. With the escalating number of pediatric patients requiring cardiac surgery, efficient use of facilities by fast track cardiac anesthesia and resource utilization resulted in the adoption of early tracheal extubation techniques in cardiac surgery. Fast track approach in cardiac surgery is a perioperative process which involves rapid progress from preoperative through intra operative and discharge from hospital. Early extubation is one of the major components of fast track [1].

Recent technological advances in diagnostic cardiology, anesthesia, surgery, extracorporeal techniques and perioperative management strategies contributed to successful early extubation. This avoids potentially deleterious effects of mechanical ventilation such as – laryngotracheal trauma, barotrauma, pneumothorax, mucus plugging in the endotracheal tube, incorrect positioning, kinking of the tube, accidental extubation and ventilator associated pneumonia [2-4]. In order to reduce or eliminate these adverse effects of prolonged intubation and to reduce the hospital costs and iatrogenic complications, we studied the concept of early extubation that is within four hours after surgery in surgical closure of ventricular septal defect.

Aim of the Study

The purpose of the present study was to determine the feasibility of early extubation and to know the risk factors for delayed extubation in children who underwent surgical closure of the ventricular septal defect. The goal was to extubate as many patients as feasible within four hours after surgery. This was defined as early extubation.

Materials and Methods

This is a prospective study of 87 consecutive patients undergoing surgical closure of ventricular septal defect between January 2010 and April 2010. The essential aspects of early extubation included choice of anesthetic agents, hemodynamic stability and good postoperative analgesia. The anesthesia was induced with intramuscular ketamine 5 mg/kg and glycopyrrolate 10 mcg/kg. Vecuronium 0.1 5mg/kg was given to facilitate intubation. Maintenance anesthesia consisted of titrated doses of fentanyl (1 mcg/kg boluses), low concentration of sevoflurane, midazolam (0.05 mg/kg) and vecuronium (0.5-0.1mg/kg) as clinically indicated.

Surgery was achieved through a median sternotomy, cardiopulmonary bypass, aortic cross-clamping, moderate hypothermia at 28°C and blood cardioplegic arrest. All ventricular septal defects were closed with an autologous pericardial patch pretreated with glutaraldehyde 6% for 15 minutes using continuous suture technique. Surgical technique was standardized to all patients Modified ultra filtration was done if the patient's weight was less than 5 kg in addition to severe pulmonary artery hypertension. In patients who had severe pulmonary artery hypertension, pulmonary artery pressure was measured while coming off pump. All patients were weaned off pump with nitroglycerine 0.5mcg/kg/mt and dobutamine

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5 mcg/kg/mt infusions. Additional inotrope of epinephrine 0.1mcg/kg/mt infusion was added if the need arise.

For early extubation, criteria such as stable haemodynamics, warm peripheries, adequate blood gas exchange, adequate muscle strength, satisfactory urine output, acceptable haematocrit acceptable chest tube drainage and adequate pain control was considered. Post- operative transthoracic echocardiogram was done in all patients before extubation. Post operative pain was managed with Inj.fentanyl and sedation with Inj.midazolam. Inotropic support and oxygen tapered clinically. Single team carried out all the operations. The early (less than 4 hours) and late (more than 4 hours) extubation groups were compared by patient's age, sex, weight, severity of pulmonary artery hypertension , type of ventricular septal defect , duration of cardiopulmonary bypass and duration of aortic cross clamp.

	Sex	Number of patients	Mean(minutes)	Std. Deviation
DOV	Male	49	160.2	183.6
	Female	38	211.84	203.9

DOV- duration of ventilation

Table 1: Difference in duration of ventilation between the two genders.

Variable	Range		Mean	Standard Deviation	P value
	Minimum	Maximum			
Weight in kg	3.50	52	16.8534	10.49	0.627
Age in years	.34	26	6.6706	4.86	0.519
CPB time in minutes*	28	148	53.4828	20.33	0.008
ACL in minutes*	15	72	30.11	13.92	0.027

*Level of significance was set < 0.05.
CPB-cardiopulmonary bypass
ACL-aortic cross clamp

Table 2: Affect of Age, weight, cardiopulmonary bypass time and cross clamp time on the duration of ventilation.

Multiple Comparisons

Dependent Variable: DOV
Tukey HSD

(I) PAH	(J) PAH	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Mild	Moderate	-54.118	48.712	.510	-170.34	62.11
	Severe	-102.518	50.289	.109	-222.51	17.47
Moderate	Mild	54.118	48.712	.510	-62.11	170.34
	Severe	-48.400	52.523	.628	-173.72	76.92
Severe	Mild	102.518	50.289	.109	-17.47	222.51
	Moderate	48.400	52.523	.628	-76.92	173.72

PAH-Pulmonary artery hypertension
Sig-Significance

Table 3:

Multiple Comparisons

Dependent Variable: DOV
Tukey HSD

(I) Type	(J) Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
PM	SA	-30.444	51.495	.825	-153.31	92.42
	MUS	17.175	51.495	.941	-105.69	140.04
SA	PM	30.444	51.495	.825	-92.42	153.31
	MUS	47.619	60.134	.709	-95.86	191.10
MUS	PM	-17.175	51.495	.941	-140.04	105.69
	SA	-47.619	60.134	.709	-191.10	95.86

PM-perimembranous
MUS-muscular
SA-subarterial
Sig-Significance

Table 4: Type of ventricular septal defect and duration of ventilation.

Data analysis

Descriptive statistics were obtained for all variables using the SPSS statistics 17.0 software package. These included continuous and discrete variables which were analyzed accordingly with an unpaired t-test, Mann-Whitney Test, chi square test, Fisher exact test , bi variate correlation, Nonparametric correlations (Kendall's tau-b), ANOVA and Kruskal-Wallis Test. A multivariate logistic regression model was used to test for the independent influence of various perioperative factors on early extubation. Logistic regression model was developed to predict the occurrence of delayed extubation (>4hours) based on pre-operative variables in patients undergoing ventricular septal defect closure. Level of significance was set at less than 0.05.

Results

Overall, 78.2% (68) of patients were extubated within 4 hours and rest of the 21.8% (19) patients was extubated after 4hours. There was no major morbidity or mortality during the hospital stay.

Sex

Of the 87 patients comprising the study group, 49(56.3%) were male and 38(43.7%) were female. Mean duration of ventilation among male patients was 160.2 minutes and mean duration of ventilation among female patients was 211.84 minutes. In spite of this difference, Non Parametric two independent samples test (Mann-Whitney test) showed no significance difference in duration of ventilation between the two genders (Table 1).

Age

The mean age of the patient was 6.67 years. The age varied between 3 months to 26 years. Age did not affect the duration of ventilation as shown by Table 2.

Weight

The mean weight of the patient was 16.85kg. The weight varied between 3.5 to 52 kg. Weight did not affect the duration of ventilation as shown by Table 2.

Cardiopulmonary bypass time

The mean cardiopulmonary bypass time was 53.8 minutes. The cardiopulmonary bypass time was statistically significant with duration of ventilation as shown by Table 2.

Cross clamp time

The mean cross clamp time was 30.11minutes. The cross clamp time was statistically significant with duration of ventilation as shown by Table 2.

Severity of pulmonary artery hypertension

The number of patients in mild pulmonary artery hypertension was 34, moderate pulmonary artery hypertension was 28 and severe pulmonary artery hypertension was 25. The mean duration of ventilation in mild pulmonary artery hypertension was 135.8minutes, moderate pulmonary artery hypertension was 190 minutes and severe pulmonary artery hypertension was 238.4minutes. The duration of ventilation between these three groups was not statistically significant as shown by Table 3.

Type of ventricular septal defect

The number of patients in perimembranous ventricular septal defect was 45, subaortic ventricular septal defect was 21 and muscular ventricular septal defect was 21. The mean duration of ventilation in perimembranous ventricular septal defect was 179.56 minutes, subaortic ventricular septal defect was 210 minutes and muscular ventricular septal defect was 162.38 minutes. The duration of ventilation between three groups was not statistically significant as shown by Table 4.

Overall there was no correlation between duration of ventilation and age, weight, severity of pulmonary artery hypertension and type of ventricular septal defect. There was a correlation between the duration of ventilation and duration of cardiopulmonary bypass and aortic cross clamp. Also inotrope usage did not affect the duration of ventilation.

Discussion

Prolonged mechanical ventilation was an essential part of postoperative care in cardiac surgery during its developing years. Recent advances in surgical and anesthetic techniques have facilitated early extubation following paediatric cardiac surgery. Potential benefits of an early extubation are decreased cardiac and respiratory morbidity, increased cardiac performance and lower rate of nosocomial pneumonia [5-9]. As a fundamental component of the fast-track protocols, early extubation has been shown to expedite intensive care unit discharge as well as overall length of stay thus resulting in reduced cancellation of surgery and decreased cost of patient care [10].

The concept of early extubation following paediatric cardiac surgery arose in the 1980s but did not gain widespread acceptance until recent years. Today's economic climate has prompted universal interest in early extubation following open heart surgery. Usage of short-acting anesthetic agents and lower doses of opioids has made this approach a feasible option when coupled with optimization in surgical technique and myocardial strategies. Early extubation of children after cardiac surgery has been suggested as a safe alternative to prolonged postoperative intubation but is still not common practice. Variables that have been shown in some studies to affect ventilation duration include younger age, severe pulmonary artery hypertension and longer cardiopulmonary bypass & aortic cross clamp duration, postoperative bleeding, congestive heart failure and high inotrope requirement [11].The variables which delayed the extubation in our study was longer cardiopulmonary bypass & aortic cross clamp duration.

Early extubation was successfully achieved in the majority of patients supports the hypothesis that there should be no arbitrary time limit for postoperative extubation. In fact, we believe that there is no specific time impediment to extubation following ventricular septal defect closure. In our institution, patients are extubated when they meet standard criteria: awake, warm, not bleeding significantly, hemodynamically stable, adequate oxygenation and ventilation. Adequate patient physiologic reserve together with optimized postoperative intensive care unit care should be the factors that determine the proper timing of early extubation. Analysis of the preoperative demographics showed no difference between patient's extubated in fewer than 4 hours and those extubated later.

Cardiopulmonary bypass duration has been associated with higher incidence of prolonged ventilation [12,13]. Possible mechanisms for such association are reduced lung compliance, decreased functional residual capacity, increased alveolar-arterial oxygen pressure gradient and atelectasis [14]. In agreement with other reports from the literature the shortened cardiopulmonary bypass and aortic cross-clamp times was noted among patients extubated in fewer than 4 hours. It appears that although very few demographic parameters can distinguish patients capable of undergoing extubation in fewer than 4 hours, intraoperative factors such as cardiopulmonary bypass and aortic cross-clamp time may play important roles in allowing patients to be extubated earlier in the intensive care.

Pulmonary hypertension often complicates the perioperative care of many children with ventricular septal defect. Chronically excessive pulmonary blood flow contributes to progressive dysfunction of the mechanisms of pulmonary vasorelaxation [15]. Changes in the pulmonary vascular endothelial surface and increased production, release or activation of serine elastase in the vessel wall may contribute to development of pulmonary vascular obstructive changes. In addition, endothelin, a potent vasoconstrictor peptide released from endothelial cells is elevated in children with pulmonary hypertension secondary to congestive heart disease [16,17]. Pulmonary artery hypertension does not seems to be a contraindicating factor to early extubation in patients who underwent ventricular septal defect closure[18]. In our series neither severity of pulmonary artery hypertension or type of ventricular septal defect affected the duration of ventilation.

Conclusion

This study shows that only duration of cardiopulmonary bypass and cross clamp time seem to be a contraindicating factor to early extubation in patients who have undergone ventricular septal closure. Severity of pulmonary artery hypertension, type of ventricular septal defect, age and weight do not seem to be a contraindicating factor to early extubation. Early extubation is highly challenging and involves interplay of several complex factors. This process requires continuous evaluation, critical reappraisal and emphasis on multidisciplinary approach with particular attention to availability and expertise of nursing staff and medical/paramedical personnel involved in patient care. The most important factor for early extubation may be to approach all of these patients as if they have the potential to be extubated early and then optimize the perioperative events to achieve this goal. When treated in this manner, neonates and young infants undergoing cardiac operations for repair of congenital heart defects can be successfully extubated early in the postoperative period.

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