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Original Article

Early extubation in tetralogy of Fallot patients after complete repair

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Abstract *Aim:* To document the feasibility of early extubation and to know the effect of age, weight, and post-operative right ventricle/left ventricle ratio in early extubation in intracardiac repair for tetralogy of Fallot. *Materials and methods:* This is a prospective study of 76 consecutive patients undergoing intracardiac repair between January, 2010 and April, 2010. The patients were compared between duration of ventilation with age, weight, and post-operative left ventricle/right ventricle ratio. *Results:* In the age group less than 10 years, 47 patients were extubated within 4 hours and 12 after 4 hours. In the age group of 10–20 years, eight patients were extubated within 4 hours and seven patients after 4 hours. In the more than 20 years category, one patient was extubated within 4 hours and the other after 4 hours. In the weight category less than 10 kilograms, 17 patients were extubated within 4 hours and seven patients after 4 hours. In the 10–20 kilogram category, 27 patients were extubated before 4 hours and four patients after 4 hours. In the more than 20-kilogram category, 12 patients were extubated before 4 hours and nine patients after 4 hours. Where the ratio was less than 0.5, 47 patients were extubated within 4 hours and 14 patients after 4 hours. Where the ratio was greater than 0.5, nine patients were extubated within 4 hours and six patients after 4 hours. *Conclusion:* There was no correlation between duration of ventilation with age, weight, and right ventricle/left ventricle ratio. Early extubation in patients after intracardiac repair in tetralogy of Fallot is safe and effective.

Keywords: Cyanosis; fast track; congenital

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The desire to reduce hospital costs and the iatrogenic complications in paediatric cardiac surgery included the use of short-acting anaesthetic drugs, early extubation, reduced intensive care therapy, and hospital stay for children. With the escalating number of children requiring cardiac surgery, the efficient use of facilities by fast track cardiac anaesthesia and resource utilisation resulted in the adoption of early tracheal extubation techniques in cardiac surgery. A fast track approach in cardiac surgery is a perioperative process that involves rapid progress from pre-operative period through intra-operative period and discharge from hospital. Early extubation is one of the major components of fast track.[1]

Recent technological advances in diagnostic cardiology, anaesthesia, surgery, extracorporeal techniques, and perioperative management strategies contributed to successful early extubation. This avoids the potentially deleterious effects of mechanical ventilation, such as laryngotracheal trauma, barotrauma, pneumothorax, mucus plugging in the endotracheal tube, incorrect positioning, kinking

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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 4 hours after surgery in intracardiac repair for tetralogy of Fallot.

Aim

The purpose of this study was to document the feasibility of early extubation and to know the effect of age, weight, and post-operative right ventricle/left ventricle ratio in early extubation in intracardiac repair for tetralogy of Fallot.

Goal

Extubate as many patients after intracardiac repair within 4 hours after surgery, which was defined as early extubation.

Materials and methods

This is a prospective study of 76 consecutive patients undergoing intracardiac repair between January, 2010 and April, 2010. The necessary elements of early extubation included choice and titrated use of anaesthetic drugs, good surgical repair, haemodynamic stability, adequate rewarming, and sustained post-operative normothermia and post-operative pain control. The patients were given injection Ketamine 5 milligram per kilogram intramuscular and injection Glycopyrrolate 10 millicentigram per kilogram in the pre-operative area. The operation theatre was equipped and drugs loaded as per our institution protocol. Pre-induction monitors included a pulse oximeter, an electrocardiogram, and a bispectral index. Injection vecuronium 0.15 milligram per kilogram was given to facilitate intubation. Post-induction monitors were invasive blood pressure, temperature, central venous pressure, urine output, end-tidal carbon dioxide, and serial arterial blood gas analysis. Anaesthesia was maintained with titrated doses of injection fentanyl, low concentration of sevoflurane, injection midazolam, and injection vecuronium.

Surgical technique was standardised in all patients. A single team carried out all the operations. Surgical steps included median sternotomy, heparinisation with an activated clotting time of more than 400 seconds, aortic and bicaval cannulations, cardiopulmonary bypass, aortic cross-clamping, moderate hypothermia at 28 degrees Celsius, and blood cardioplegia arrest. In all the repairs, ventricular septal defect was closed using 0.6% w/v glutaraldehyde-treated autologous pericardial patch. Infundibular resection was performed via the right atrium for infundibular stenosis in a majority of patients. Pericardial patch augmentation for right ventricular outflow tract obstruction in case of transatrial repair was not possible. Once the patient was fully rewarmed to the nasopharnygeal temperature of 37 degrees, it was weaned off bypass with injection Dobutamine as an inotrope and injection NTG as a vasodilator. Adrenaline was used as the second line of drug infusion. Right and left ventricular pressures were noted during the off-bypass period.

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 were considered. The decision to extubate was based on the clinical picture rather than numerical values. Post-operative transthoracic echocardiogram was performed in all patients before extubation. Post-operative pain was managed with injection fentanyl and sedation with injection midazolam. Inotropic support and oxygen tapered clinically. The early less than 4 hours and delayed greater than 4 hours extubation groups were compared with the patient's age, weight, and right ventricle to left ventricle ratio.

Data analysis

Descriptive statistics were obtained for all variables using the SPSS statistics 17.0 software package. The variables were analysed according to Pearson's Chi-square test, Fisher's Exact test, and non-parametric correlations (Kendall's tau_b). A logistic regression model was used to test for independent influences of various perioperative factors on early extubation in patients undergoing intracardiac repair.

Results

Overall, 56 (73.7%) patients were extubated within 4 hours and the remaining 20 (26.3%) patients were extubated after 4 hours. The patients extubated within 4 hours were grouped as normal and those extubated after 4 hours were grouped as abnormal.

Age

The mean age was 7.284 years. Age was divided into three categories: less than 10 years – 59 patients; 10–20 years – 15 patients; and more than 20 years – 2 patients. In the age group less than 10 years of age, 47 patients were extubated within 4 hours and 12 were extubated after 4 hours. In the age group 10–20 years, eight patients were extubated within 4 hours and seven were extubated after 4 hours. In the more than 20 years age category, one patient was extubated within 4 hours

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Table 1. Age and duration of ventilation.

	Duration of ventilation		
	Normal	Abnormal	Total
Age			
<10 years			
Count	47	12	59
Total (%)	61.8	15.8	77.6
10–20 years			
Count	8	7	15
Total (%)	10.5	9.2	19.7
>20 years			
Count	1	1	2
Total (%)	1.3	1.3	2.6
Total			
Count	56	20	76
Total (%)	73.7	26.3	100.0

Table 2. Weight and duration of ventilation.

	Duration of ventilation		
	Normal	Abnormal	Total
Weight			
<10 kg			
Count	17	7	24
Total (%)	22.4	9.2	31.6
10–20 kg			
Count	27	4	31
Total (%)	35.5	5.3	40.8
>20 kg			
Count	12	9	21
Total (%)	15.8	11.8	27.6
Total			
Count	56	20	76
Total (%)	73.7	26.3	100.0

and the other was extubated after 4 hours. Age did not affect the duration of ventilation as shown in Table 1. Despite the third category sharing an equal number of patients in early extubation and delayed extubation, owing to less sampling, a correlation comment cannot be made regarding age and early extubation.

Weight

The mean weight was 18.507 kilograms. Weight was divided into less than 10 kilograms – 24 patients; 10–20 kilograms – 31 patients; and more than 20 kilograms – 21 patients. In the weight category less than 10 kilograms, 17 patients were extubated within 4 hours and seven patients after 4 hours. In the 10–20-kilogram category, 27 patients were extubated before 4 hours and four patients after 4 hours. In the more than 20-kilogram category, 12 patients were extubated before 4 hours and 9 patients after 4 hours. Weight did not affect the duration of ventilation as shown in Table 2.

Table 3. RV/LV ratio and duration of ventilation.

	Duration of ventilation		
	Normal	Abnormal	Total
RV/LV ratio post-operative bypass			
< 0.5			
Count	47	14	61
Total (%)	61.8	18.4	80.3
>0.5			
Count	9	6	15
Total (%)	11.8	7.9	19.7
Total			
Count	56	20	76
Total (%)	73.7	26.3	100.0

LV = left ventricle; RV = right ventricle

Right ventricle/left ventricle ratio

The mean right ventricle/left ventricle ratio was 0.413. This ratio was divided into two categories: those with a ratio less than 0.5 – 61 patients and those with a ratio greater than 0.5 – 15 patients. In the first category, 47 patients were extubated within 4 hours and 14 patients after 4 hours. In the second category, nine patients were extubated within 4 hours and six patients after 4 hours. The right ventricle/left ventricle ratio did not affect the duration of ventilation as shown in Table 3.

Our mean cardiopulmonary time was 60.8 minutes and aortic cross-clamp time was 30.11 minutes. There was no correlation of duration of ventilation with age, weight, and right ventricle/left ventricle ratio (Table 4).

Discussion

Total correction of tetralogy of Fallot has been in practice for the past four decades. Adoption of the transatrial or transpulmonary approach has shown better results when compared to transventricular repair, which mostly results in ventricular arrhythmias and right ventricular dysfunction.[5–7] We preferred to perform early primary intracardiac correction to avoid late complications like right ventricular dysfunction and arrhythmias. The transatrial/transpulmonary repair of tetralogy of Fallot is associated with remarkably low morbidity and mortality,[8] which was also true in our experience. Dynamic right ventricular outflow tract gradients decline significantly, irrespective of their severity after transatrial repair of tetralogy of Fallot.[9]

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Table 4. Correlation between age, weight, RV/LV ratio, and duration of ventilation.

	Correlations			
	Age	Weight	RV/LV ratio post-operative bypass	Duration of ventilation
Age				
Pearson's correlation	1	0.734**	0.278*	0.276*
Significance (two-tailed)		0.000	0.015	0.016
n	76	76	76	76
Weight				
Pearson's correlation	0.734**	1	0.178	0.361**
Significance (two-tailed)	0.000		0.125	0.001
n	76	76	76	76
RV/LV ratio post-operative bypass				
Pearson's correlation	0.278*	0.178	1	0.062
Significance (two-tailed)	0.015	0.125		0.596
n	76	76	76	76
Duration of ventilation				
Pearson's correlation	0.276*	0.361**	0.062	1
Significance (two-tailed)	0.016	0.001	0.596	
n	76	76	76	76

*Correlation is significant at the 0.05 level (two-tailed)
**Correlation is significant at the 0.01 level (two-tailed)
LV = left ventricle; RV = right ventricle

Prolonged mechanical ventilation was an essential part of post-operative care in cardiac surgery during its developing years. High-dose narcotics were used to blunt stress response during surgery, and to avoid haemodynamic instability and pulmonary vasoconstrictive responses during suctioning.[10–13] The potential benefits of early extubation are decreased cardiac and respiratory morbidity, increased cardiac performance, and a lower rate of nosocomial pneumonia.[14–16] The early tracheal extubation of children is not a new concept, but has received renewed attention with the evolution of fast track management for cardiac surgical patients. As a fundamental component of the fast-track protocols, early extubation is shown to expedite intensive care unit discharge as well as the overall length of stay, thus resulting in decreased cost of patient care.

Previously, extubation following intracardiac repair in tetralogy of Fallot was delayed mainly due to post-operative right ventricular dysfunction, pulmonary regurgitation, and bleeding. Good perioperative management and complete surgical repair have answered the above two concerns and made early extubation possible in intracardiac repair. Early extubation was possible in 56 patients in our study. In the remaining patients, extubation was mainly delayed because of excessive bleeding and right ventricular dysfunction. There is hardly any previous literature that has noted a study of correlation between the right ventricle/left ventricle ratio and early extubation. Our study showed there was no correlation between the right ventricle/left ventricle ratio and extubation time. Early extubation of children after cardiac surgery is suggested as a safe alternative to prolonged post-operative intubation but is still not common practice. Early extubation was successfully achieved in the majority of patients, supporting the hypothesis that there should be no arbitrary time limit for post-operative extubation.[17] The low incidence of perioperative morbidity in our series suggests that early extubation methodology in post-operative cardiac patients is safe and effective.

Conclusion

Early extubation after intracardiac repair is a major component of fast track in cardiac anaesthesia. This is definitely teamwork success that involves the surgeons, anaesthesiologists, perfusionists, intensivists, and para-medical staff. This study shows that there was no correlation between duration of ventilation with age, weight, and right ventricle/left ventricle ratio. Early extubation in patients after intracardiac repair in tetralogy of Fallot is safe and effective.

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