

## Original Research Article

# Fast-track paediatric and adult congenital cardiac surgery

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**Received:** 24 April 2023

**Accepted:** 09 May 2023

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## ABSTRACT

**Background:** Aim of the study was to evaluate the benefits and predictors of success of fast-track and ultra-fast track paediatric and congenital cardiac surgery.

**Methods:** Retrospective observational study of paediatric and adult congenital cardiac surgical patients presented for surgery in period between October 2023 and April 2024 at Queen Alia heart institute (QAHI). Patients' demographic, clinical and perioperative data were collected and analysed. Patients were divided into groups according to their extubation time: UFTE (Ultra-fast track extubation group, FTE (Fast-track extubation) group, CE (Conventional extubation) group and DE (Delayed extubation) group. All groups were compared in reference to their age, weight, CPB time, AXC time, length of ICU stay and hospitalisation time. Statistical analysis was done to determine the benefits of early extubation after paediatric and congenital cardiac surgery. Predictors of early and DE were studied.

**Results:** Data of 73 paediatric and adult congenital cardiac surgical patients was reviewed and analysed. Patients were 37 males and 36 females. Average age of patients was 11.1 years (ranged from 5 days to 57 years). Average weight of patients was 29.3 kg (ranged from 2.4 to 109 kg) and average height was 104.8 cm. Average time of tracheal extubation was 13.1 hours (ranged from 0 to 168 hours). UFTE was accomplished in 11 patients (15.1%). FTE was done in 19 patients (26%). CE (between 6 and 24 hours) was carried out in 38 patients (52.1%) and DE (after more than 24 hours) was noted in 5 patients (6.8%). The average ICU stay was 3 days (ranged from 1 to 15 days). Patients from the UFTE group had the shortest average ICU stay of 1.2 days, while patients from the FTE group had an average ICU stay of 1.9 days. Patients from the CE and the DE groups had an average ICU stay of 4 days and 9.4 days, respectively. Length of hospitalisation was shortest in the UFTE group with an average of 6 days. The hospitalisation time doubled in the DE group to 12 days. The shorter the CPB and AXC times the more likely patients were to have UFTE and FTE. Neonates were less likely to have UFTE and FTE.

**Conclusions:** UFTE and FTE were associated with shorter ICU stay and hospitalisation time. Predictors of UFTE and FTE were simple cardiac procedures, shorter CPB and AXC durations. Neonatal age and low body weight paediatric cardiac surgical patients were predictors for conventional or DE.

**Keywords:** Cardiac, Extubation, Fast track, Hospitalisation, Paediatric, Surgery

## INTRODUCTION

In the past, cardiac surgical patients were given high-dose opioid-based anaesthesia and were mechanically ventilated overnight in the surgical intensive care unit after

surgery.<sup>1,2</sup> Currently many cardiac anaesthetists extubate selected cardiac surgical patients on the operating table or within hours from their arrival to the ICU. Fast-tracking in cardiac surgery/anaesthesia refers to the concept of early tracheal extubation, early mobilization and early hospital

discharge in an effort to reduce resource utilization and perioperative morbidity.<sup>3</sup> Through careful patients' selection and perioperative optimisation, fast-tracking can be achieved in many patients undergoing surgery for congenital heart disease. Fast-tracking cardiac surgery and anaesthesia is a multi-disciplinary approach that involves anaesthetists, cardiologists, surgeons and intensivists and is a keystone of the enhanced recovery after cardiac surgery (ERAS) protocol.<sup>4</sup> By definition, fast-track cardiac anaesthesia/ surgery refers to tracheal extubation within 6 hours from admission to postsurgical intensive care unit, while the ultra-fast-track cardiac anaesthesia/ surgery refers to theatre 'on-table' extubation immediately after surgery.<sup>5,6</sup> In the past decade, many cardiac surgical units have implemented the fast tracking approach in paediatric cardiac surgical population, safely and successfully extubating patients in the operative theatre with described advantages in terms of reduced morbidity and ICU/hospital lengths of stay.<sup>7</sup> The feasibility of fast tracking can be attributed to coordinated multidisciplinary team work involving perioperative optimisation, minimisation of preoperative fasting time, utilisation of mini incisions (mini-sternotomies and mini-thoracotomies), multi-modal analgesia, and use of newer anaesthetic agents like modern inhalational agents, short-acting opioids, and reversal of muscle relaxants at the end of surgery.<sup>8,9</sup>

The potential advantages of fast-tracking in paediatric and congenital cardiac surgery are reduced ventilator-associated complications like accidental tracheal extubation, ventilator associated pneumonia (VAP) pulmonary hypertensive crisis during endotracheal tube suctioning, hospital acquired infections, laryngeal oedema, croup, reduced delirium, increased patient comfort, increased parents satisfaction, early ambulation, early neurological assessment, early enteral feeding, decreased ICU/hospital stay and reduction of resource utilisation.<sup>10</sup> However, many factors can deter anaesthetists from pursuing fast tracking in paediatric and congenital cardiac surgery such as long cardiopulmonary bypass (CPB) or aortic cross clamp durations, surgical events such as excessive bleeding or surgical trauma, hemodynamic instability, high inotropic and vasopressor requirements, coagulopathy, surgical and CPB critical events, left open sternum, malnourished neonates or infants and high risk complex and long surgical procedures.<sup>11</sup> Therefore, fast tracking or ultra-fast tracking is a shared multidisciplinary decision taken on individual patient's basis, keeping patient's safety as the topmost main concern.<sup>12</sup> In this study, we will look at the benefits and predictors of success of UFTE and FTE. In this study, we will evaluate potential benefits of early extubation and predictors of its success.

**METHODS**

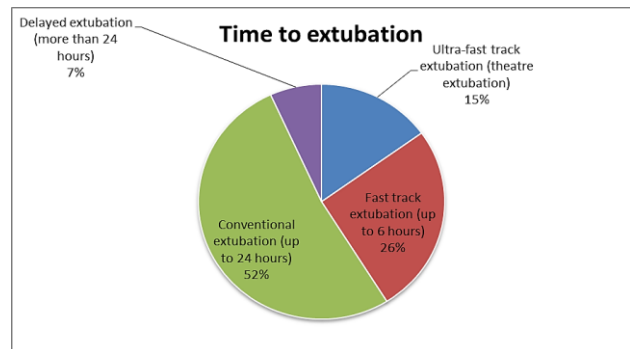
This is a retrospective observational analysis of paediatric and adult congenital cardiac surgical patients presented for surgery in the period between October 2023 and April 2024 at QAHI. Patients' demographic, clinical and perioperative data were collected and analysed. Patients

were divided into groups according to their tracheal extubation time: UFTE group, FTE group, CE group and DE group. All groups were compared in reference to their length of ICU stay, hospitalisation time, morbidity and mortality. Statistical analysis was done using Microsoft excel to determine the benefits of early extubation after paediatric and congenital cardiac surgery. Predictors of UFTE and FTE were studied. Ethical committee approval obtained.

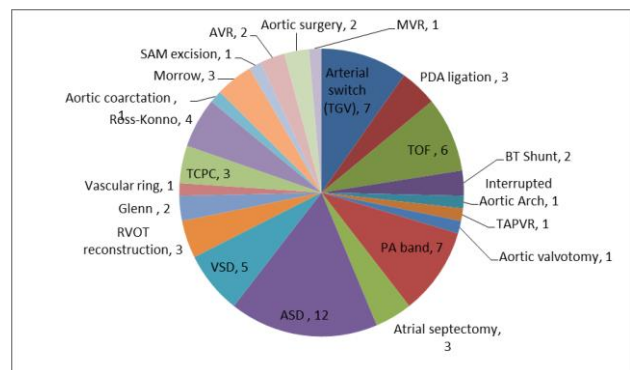
Definitions and abbreviations: UFTE: extubation in operative theatre immediately after surgery, FTE: extubation within 6 hours from arrival to ICU, CE: extubation between was 6 and 24 hours from arrival to ICU and DE: extubation after more than 24 hours from arrival to ICU

**RESULTS**

Paediatric and adult congenital cardiac surgical procedure of 73 patients (58 paediatric and 15 adult) were retrospectively reviewed and analysed. Patients were 37 males and 36 females. Average age of patients was 11.1 years (ranged from 5 days to 57 years). Average weight of patients was 29.3 kg (ranged from 2.4 to 109 kg) and average height (length) was 104.8 cm (ranged from 46 to 178 cm).



**Figure 1: Time to extubation.**



**Figure 2: Paediatric and adult congenital cardiac procedures.**

Average time of tracheal extubation was 13.1 hours (ranged from 0 to 168 hours). Extubation in the operative

room immediately after surgery (UFTE) was accomplished in 11 patients (15.1%). Extubation within 6 hours from arrival to ICU (FTE) was done in 19 patients (26%). CE (between was 6 and 24 hours) was carried out in 38 patients (52.1%) and DE (after more than 24 hours) was noted in 5 patients (6.8%).

Surgical procedures included in this study are shown in Figure 2.

The average ICU stay was 3 days (ranged from 1 to 15 days). Patients from the UFTE group had the shortest average ICU stay of 1.2 days, while patients from the FTE group had an average ICU stay of 1.9 days. Patients from the CE and the DE groups had an average ICU stay of 4 days and 9.4 days, respectively. Length of hospitalisation was shortest in the UFTE group with an average of 6 days. The hospitalisation time increased in the FTE group to 6.4 days and the CE group to 7.9 days. It doubled in the DE group to 12 days (Table 1).

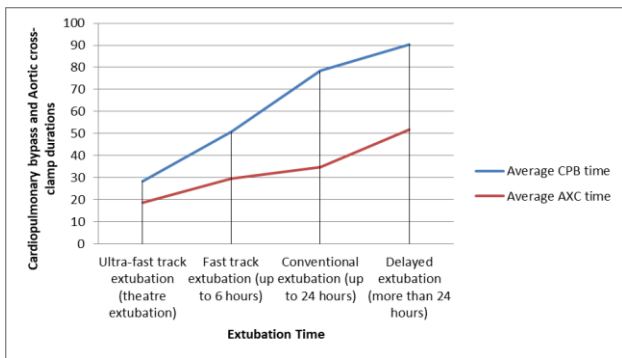


Figure 3: Impact of CPB and AXC times on extubation.

The shorter the CPB and AXC times the more likely patients were to have UFTE and FTE. Longer CPB and AXC times were associated with CE or DE (Figure 3).

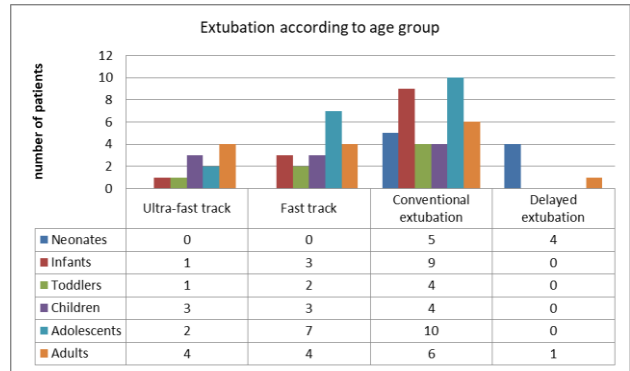


Figure 4: Impact of age on extubation time.

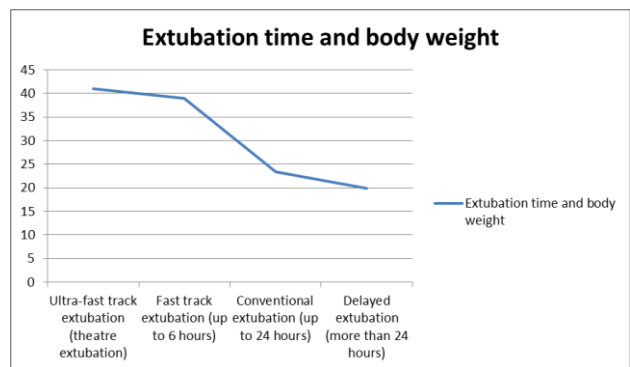


Figure 5: Impact of body weight on extubation time.

The study included 9 neonates; they had CE (5 patients) or DE (4 patients). The number of infants included was 13 patients; one infant had UFTE, 3 infants had FTE and 9 infants had CE. Higher percentages of toddlers, children, adolescents and adults were likely to have UFTE and FTE (Figure 4). Patients with small body weight (neonates and infants) had CE and DE, while patients with higher body weight more likely to have UFTE and FTE (Figure 5).

Table 1: Patients' characteristics and extubation time.

Variables	UFTE, 0 (Immediate, in theatre)	FTE, up to 6 hours from arrival to ICU	CE, 6-24 hours from arrival to ICU	DE, more than 24 hours after arrival to ICU	Total
N (%)	11 (15.1)	19 (26)	38 (52.1)	5 (6.8)	73 (100)
ICU stay (days)	1.2	1.9	4	9.4	3.1
Hospital stays (days)	6	6.4	7.9	12	8.8
Average age (in years)	9.4	9.5	15.2	19.3	11.4
Average weight (kg)	40.6	39.6	23.4	19.9	29.2
CPB time (min)	28.5	50.7	78.4	90.4	66.9
AXC time (min)	18.5	29.7	34.7	51.8	36.2
Neonates	0	0	5	4	9
Infants	1	3	9	0	13
Toddlers	1	2	4	0	7
Child	3	3	4	0	10
Teen	2	7	10	0	19
Adult	4	4	6	1	15

## DISCUSSION

Early extubation is one of the elements of the ERAS (enhanced recovery after surgery) cardiac society's guidelines for perioperative care in cardiac surgery.<sup>13</sup> Early extubation is defined as extubation within six hours from arrival to the ICU.<sup>14</sup> This is also termed FTE. Likewise, if the patient was extubated immediately after cardiac surgery; it is called UFTE.<sup>15</sup> There is strong evidence in literature that fast track paediatric cardiac surgical and anaesthetic management is feasible, safe, and cost-effective.<sup>16</sup> The reduction of time of mechanical ventilation, ICU stay and hospitalisation time decreases ventilator associated complications, ICU and hospital acquired infections, make more free beds in the intensive care and reduces health care costs. With proper pre-operative care, patients' optimisation, reduction of fasting hours, multimodal analgesia, smaller surgical incisions (mini-sternotomies and mini-thoracotomies), shorter acting anaesthetic medications, shorter CPB (cardiopulmonary bypass) and AXC (aortic cross-clamp) durations and with proper patients' selection; UFTE and FTE became standard of care in many paediatric cardiac surgical procedures.<sup>17</sup>

In our study, early extubation (UFTE and FTE) was achieved in 41% of this study population. We also found that the earlier the tracheal extubation was; the shorter was the ICU stay and the hospitalisation time. Moreover, patients from the UFTE group had on average half the time of hospitalisation of the DE group (Table 1).

As mentioned earlier, early extubation can be divided into UFTE and FTE. UFTE was feasible in 15.1% of patients in our analysis. This group of patients had on average the shortest CPB (cardiopulmonary bypass) and AXC (aortic cross clamp) times; which may denote more simple and uncomplicated procedures like closure of an atrial septal defect (ASD) or a ventricular septal defect (VSD) or excision of sub-aortic membrane (SAM). This may also vary between cardiac surgeons according to their skills and experience (Figure 3). None of the patients in the UFTE group was a neonate; probably due to immaturity of this patients' group, their low body weight, muscular weakness, easy fatigability and their propensity to postoperative apnoea. Using of UFTE in infants, toddlers, children and adolescents was effective. It was associated with reduced ICU stay and earlier hospital discharge (Figure 4). Feng et al reported efficacy of the UFTE protocol on infants and toddlers and they also reported reduction of inotropic requirements with UFTE.<sup>18</sup> When we examined the impact of body weight on early extubation, we found that neonates and low body weight infants were more likely to have CE (up to 24 hours from their arrival to ICU) or DE (after more than 24 hours) after cardiac surgery (Figure 5). Miura et al reported recurrent extubation failure in neonates and low weight infants after cardiac surgery due to multi-factorial reasons including patient-factors and ICU system-factors.<sup>19</sup> In our study,

none of the patients who had UFTE and FTE needed re-intubation post-extubation.

Limitations of this study include the observational nature of the study, the relatively small number of patients and that it is a single centre study.

## CONCLUSION

Early extubation after paediatric cardiac surgery is safe and beneficial. UFTE and FTE had the benefit of shorter ICU stay and hospitalisation time. Predictors of UFTE and FTE were shorter CPB and AXC durations. Neonatal age and low body weight paediatric cardiac surgical patients were predictors for conventional or DE.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Alomari AM, Zureiqat YJ, Hijazi I, Al-Fawares S, Al-Dogum M, Mohd AF. Fast-track paediatric and adult congenital cardiac surgery. *Int J Adv Med* 2024;11:299-303.