Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

GKDA Derg 2023;29(1):39-44
DOI: 10.14744/GKDAD.2023.46503

Research Article

Difference Among Perioperative Factors Related to Ultra-Fast Track Extubation After Fontan Completion

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ABSTRACT

Objectives: The immediate extubation technique in patients undergoing a Fontan operation is commonly used to reduce the negative effects of positive-pressure ventilation on pulmonary blood flow and provide a hemodynamic advantage. This study aimed to determine the correlation between the perioperative characteristics of patients undergoing a Fontan operation and the success of fast track extubation.

Methods: Perioperative data from patients from all age groups undergoing a Fontan operation were retrospectively analyzed and correlated with their extubation time.

Results: A table extubation was performed on 72.7% of patients undergoing a Fontan operation. Age, presence of fenestration, conduit localization, heterotaxy, cross and bypass durations, and success of ultra-fast track extubation have no significant correlation.

Conclusion: Ultra-fast track extubation strategy facilitated the hemodynamic adaptation of patients to the Fontan circulation. However, the Fontan population has little variation in early extubation characteristics.

Keywords: Airway extubation, cardiac surgery, congenital heart diseases, fontan circulation

Please cite this article as: "Biçer M, Kozan Ş, Darçın K, Çetin S, Tanyıldız M, Özden Ö, et al. Difference Among Perioperative Factors Related to Ultra-Fast Track Extubation After Fontan Completion. GKDA Derg 2023;29(1):39-44".

Introduction

Interest in reducing the duration of mechanical ventilation following Fontan operations is growing. Mechanical ventilation-associated high thoracic pressure, decreased resultant systemic and pulmonary return, and increased central venous pressure are among the disadvantages of delayed extubation in patients undergoing a Fontan operation.[1,2] Avoiding these adverse effects is important, especially in single ventricle physiology, concerning hemodynamic stabilization. The Fontan circulation is distinguished by the passive blood flow through the pulmonary vascular bed caused by the venous pressure. Spontaneous breathing was shown to increase the venous return from the systemic circulation to the pulmonary arteries.[3-6] This is caused by the negative intrathoracic pressure created during physiologic inspiration that acts as a driving force for the systemic venous return and improves the pulmonary blood flow in patients with a single ventricle. The first report by Fontan hypothesized the theoretical importance of spontaneous breathing for the hemodynamics of patients with a single ventricle, which was later confirmed by other studies.[5] Thus, early extubation was suggested to provide a physiologic benefit in patients undergoing single ventricle palliation.[2]

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Submitted: December 22, 2022 **Revised:** December 28, 2022 **Accepted:** February 12, 2023 **Available Online:** March 29, 2023
The Cardiovascular Thoracic Anaesthesia and Intensive Care - Available online at www.gkdaybd.org

However, the prevailing use of an early extubation strategy and its impact on clinical outcomes remains unconfirmed.[7] Several studies have revealed that early extubation decreases hospital and intensive care unit (ICU) length of stay, improves hemodynamics, and minimizes postoperative complications, thereby reducing cost and resource utilization.[2,4,5,7] This suggests that an early re-introduction of the physiologic breathing mechanics avoids venous stasis and improves end-organ perfusion in patients undergoing a Fontan operation due to its support on the cardiac output. A fast-tracking protocol includes a rapid mechanical ventilation discontinuation, which can sometimes be accomplished in the operating room (OR) at the end of the procedure or shortly after ICU arrival.[3] Therefore, patients with a single ventricle stand as suitable candidates for implementing a postoperative fast track extubation strategy.

Methods

This study retrospectively included 22 patients operated on for Fontan completion from 2021 and 2022 in the cohort. The same surgical team operated on all patients. Patients who were transferred to the ICU under extracorporeal membrane oxygenation support and/or died were excluded from the analysis. The perioperative in-hospital data of patients were reviewed.

Each patient's anesthetic and surgical protocol was standardized across the cohort. Anesthesia was induced with propofol at 2 mg/kg, fentanyl at 1–2 mcg/kg, rocuronium at 0.6 mg/kg, and maintained with 0.8–1 MAC sevoflurane preoperatively. The depth of anesthesia was determined with Bispectral index monitoring.

Standard aortobicaval cannulation was performed for cardiopulmonary bypass setup with mild systemic hypothermia. Cardiac arrest was achieved with aortic cross-clamping if any in-chamber intervention was planned, such as valve repairs, atrial septectomy, and intra-extra cardiac approach, for Fontan completion. Del Nido cardioplegia was used to initiate the arrest, followed by blood cardioplegia for maintenance. A fenestration was created in all patients, except for one patient in Group 1, before completing the procedure. Unbalanced common atrioventricular (AV) valves were repaired via a valvuloplasty reinforced with a polytetrafluoroethylene strip over the superior and inferior bridging leaflets of the common valve.

Surgical correction was confirmed after completing the procedure using transesophageal echocardiography. Postoperative pain was controlled with a pre-extubation parasternal block with 0.5 ml/kg of bupivacaine in 0.25% concentration. Anesthesia was discontinued 20 min after the parasternal block administration. The effects of muscle relaxants were counteracted with sugammadex (2 mg/kg).

The following parameters were considered as indicators of successful on-table extubation: confirmed surgical repair of the defect with stable hemodynamics and no evidence of relevant hemorrhage; adequate spontaneous breathing; body temperature of 36°C; and appropriate blood gas analysis with a 40% fraction of inspired oxygen. The anesthesia team and the surgeon jointly decided on extubation in a personalized, case-based manner. Perfusions of 0.2–0.5 mcg/kg/h of dexmedetomidine and analgesic doses of 0.5–1 mcg/kg/h of fentanyl were started during the patients' ICU follow-up. Patients were given non-invasive respiratory support at 2 L/kg/min per protocol.

Statistical Analysis

The Statistical Package for the Social Sciences (IBM Inc., Armonk, NY) software was used for statistical analysis and table creation. Continuous data were represented as medians and interquartile ranges. The Mann-Whitney U and independent samples t-tests were used to compare continuous data between the two groups. Pearson's chi-square and Yate's continuity correction tests were used for categorical data comparison. A p-value of <0.05 was considered statistically significant.

Results

Data about the types of pathology are summarized in Table 1. The most common cardiac pathology among the cohort was an unbalanced AV canal followed by tricuspid atresia/pulmonary stenosis/atresia. Perioperative patient data are presented in Table 2. Patient characteristics, including age, sex, weight, and body surface area, were not significantly different between the two groups. Information regarding the previous Glenn operation, such as the time of operation, and the preoperative Glenn pressure, were not significantly different between the groups. Preoperative and postoperative echocardiographic patient data were

Table 1. Pathologies of patients

Diagnosis	Number of Patients
Tricuspid atresia-pulmonary stenosis/atresia	6
Intact ventricular septum-pulmonary atresia	1
Double inlet left ventricle-pulmonary stenosis	1
Unbalanced atrioventricular canal-pulmonary atresia/stenosis	7
Hypoplastic left heart syndrome	4
Transposition of great arteries-ventricular septal defect-pulmonary stenosis	1
Double inlet right ventricle-pulmonary atresia/stenosis	2

Table 2. Perioperative patient data

	Patients (22)	Patients extubated (16)	Patient unable to be extubated (6)	p
Age (months)	49.8 (59.7–42.02)	52.5 (60.9–41.9)	47.9 (53.2–40.4)	0.417
Sex		5 females; 11 males	3 females; 3 males	0.624
Weight (kg)	14.5 (17–13)	15.1 (17–13)	13.95 (16.5–12.5)	0.631
Body Surface Area	0.62 (0.71–0.58)	0.64 (0.73–0.58)	0.6 (0.71–0.57)	0.483
Age at Glenn Operation (months)	12.5 (20.25–12.5)	12.5 (18–7.25)	12.5 (27.5–5.75)	0.824
Glenn Pressure (mmHg)	13.5 (15.25–11)	13 (15.75–10.5)	14 (15.5–11)	0.934
Main ventricle		1 right; 6 left; 11 biventricular	2 right; 2 left; 2 biventricular	0.206
Preoperative AV valve insufficiency		Grade 0: 7 patients	Grade 0: 2patients	0.403
		Grade 1: 4 patients	Grade 1: 1 patient	
		Grade 2: 3 patients	Grade 2: 3 patients	
		Grade 3: 2 patients		
Antegrade flow to pulmonary artery		4 patients	3 patients	0.267
Pulmonary banding		2 patients	3 patients	0.1
Pulmonary atresia		11 patients	5 patients	0.369
Isomerism		Right ventricle: 4		
		Left ventricle: 1	All patients had normal atrial morphology	
Mc Goon Index	2.04 (2.32–1.7)	1.93 (2.32(1.67)	2.15 (2.32–1.98)	0.252
Cross Time	104 (129–79) (7 patients)	87 (121.25–77.5)	123 (–104)	0.289
Bypass Time	128 (174.25–108.5)	125 (168.25–105.5)	136 (185.25–116.25)	0.396
Fenestration Diameter	3.6 (4–3.6)	3.6 (4–3.6)	3.8 (4–3.6)	0.717
Postoperative AV valve insufficiency		Grade 0: 9 patients	Grade 0: 3 patients	0.633
		Grade 1: 7 patients	Grade 1: 3 patients	
Intensive care unit length of stay	1 (2–1)	1 (2–1)	1.5 (3.25–0.75)	0.607
Length of hospital stay	15 (22.5–10)	14.5 (22.75–1025)	15.5 (22.5–9.75)	1

compared between the groups. Our analysis revealed no statistically significant difference in the data about the pathology, such as the dominant ventricle, presence of a preoperative or postoperative atrioventricular (AV) valve insufficiency, antegrade flow to the pulmonary artery, and presence of pulmonary atresia. The distribution viewed considering the presence of a heterotaxy syndrome revealed five isomeric patients, including four right and one left, in the on-table extubation group while none in Group 2. The presence of arrhythmia was not statistically significantly different between the groups. Only one patient from each group had arrhythmia. The two patient groups have been homogenously distributed according to preoperative hemodynamics, including saturation, hemoglobin, hematocrit, white blood cell count, and C-reactive protein. Further, the postoperative hemodynamics of patients with the analysis of the same parameters did not yield a statistically significant difference between the groups. Additionally, the McGoon index was statistically insignificant concerning the likelihood of performing fast track extubation. The analysis of cross and bypass times revealed no significant difference between the groups. Pulmonary artery reconstruction was not significantly different between the groups, and reconstruction was performed on all the included patients in the cohort. Valve repairs were performed on four patients, of whom two had extracardiac conduits while the other two had intra-extracardiac conduits. Ultra-fast track extubation was performed on 67% of patients with extracardiac conduit while on 50% of patients with intra-extra cardiac Fontan. Our study revealed no correlation between extubated Fontan in the OR and shorter ICU or hospital stays.

Discussion

The feasibility of the fast-tracking strategy for all ages has been reported.[3] However, previous studies have mentioned that the early extubation strategy is less frequently practiced in younger patients undergoing a Fontan operation with more frequent needs of reintubation while early extubation is feasible in older patients regardless of the surgical complexity.[3,8] This association was not apparent in our analysis, which revealed no significant age difference between the on-table extubation group and the non-extubated group.

The use of fenestrations in the Fontan circuit has conflict-

ing evidence.[9,10] Patients undergoing a Fontan operation with non-fenestrated procedures were more likely to be extubated early.[7,10] Similarly, previous studies concluded that fenestration alone is insufficient to ensure optimal early postoperative hemodynamics.[6] Conversely, lack of fenestration was associated with an increased risk of extubation failure in a predictive model published for failed extubations in patients undergoing a Fontan operation.[11] Our study revealed that all patients, except one, had a fenestration, thereby eliminating this variability in our study. Notably, the mentioned patient lacking a fenestration was extubated on the operating table. This patient was a 10-year-old isomeric Kawashima patient with large arteriovenous malformations acting as an escape route, thereby favoring a non-fenestrated Fontan completion approach. Therefore, we believe that fenestrations are essential to avoid acute Fontan failure by acting as an escape route for high Fontan pressures brought on by abnormal pulmonary artery anatomy or increased pulmonary vascular resistance.[9]

Regarding the operation strategy, earlier extubation was more likely to be performed in patients undergoing a Fontan operation with extracardiac conduits.[7] Our study results were consistent with the literature. A higher percentage (73.6%) of patients with extracardiac Fontan was extubated in the OR compared to patients with intra-extra cardiac conduit (66%). This can be attributed to multiple factors. Firstly, our study performed a concomitant AV valve repair or an atrial septectomy in two of the patients with intra-extra cardiac conduits along with total cavopulmonary anastomosis completion. The other patient was isomeric, and an intra-extra cardiac conduit was chosen due to the mesocardiac localization of the inferior vena cava in this patient. Hence, these patients were operated on with aortic cross-clamping, and cardiac arrest with cardioplegia under hypothermic conditions. Thus, the total surgical times, as well as bypass durations, were expectedly longer, and the overall physiologic stress imposed by the operation was considerably increased as opposed to a non-cardiac arrest approach.

The literature revealed the association between longer cardiopulmonary bypass duration and prolonged mechanical ventilation following congenital heart surgery.[3] This is unsurprising because longer cardiopulmonary bypass (CPB) times are required for increasing surgical complexity and for unexpected surgical complications.[3] Moreover, longer CPB time is associated with an increased risk of inflammatory response syndrome with generalized edema, decreased respiratory compliance, acute lung injury, and coagulopathy.[3] Contradictorily, a previously published study revealed no correlation between bypass duration and length of mechanical ventilation, nor the length of hospital stay in patients undergoing a Fontan operation.[6] Our analysis reveals similar results. We found no correlation between shorter bypass duration and on-table extubation in patients undergoing a Fontan operation. This is because the bypass durations homogenously differed among the patients in our cohort and the prolongations were not extreme. However, we excessively prolonged bypass durations, thereby affecting the extubation success.

The impact of pulmonary artery size remains debatable in a Fontan operation.[12,13] Earlier studies demonstrated that decreased pulmonary artery indices negatively impact the early hemodynamics of patients undergoing a Fontan operation.[12,13] Conversely, the modifications made to the original Fontan operation since these earlier studies must be considered when viewing the impact of the pulmonary artery size on the single ventricle hemodynamics. More recent studies have revealed that reduced pulmonary artery size, as determined by the McGoon ratio, had no negative impact on the early postoperative outcomes of patients undergoing a Fontan operation.[12] Our analysis revealed similar results. We found no statistically significant correlation between the preoperative McGoon index and the success of fast track extubation in patients undergoing a Fontan operation.

Uncertainty persists over the ideal time for performing the bidirectional cavopulmonary anastomosis.[14,15] Early-age (3–6 months) bidirectional cavopulmonary anastomosis has been frequently used in many hospitals, particularly for infants with hypoplastic left heart syndrome, to maintain ventricular and atrioventricular valve function.[15,16] Several studies revealed that early bidirectional cavopulmonary anastomosis may be performed safely and effectively.[14-16] Therefore, a delay in stage 2 palliation may have a detrimental impact on cardiac function following Fontan completion.[14] The two groups in our cohort have no statistically significant difference in the age of the Glenn operation. Conversely, our patients were in late-stage 2 palliation following the literature because the median age at the Glenn operation was 12.5 months for both groups. This is because of the presence of patients with antegrade pulmonary artery flow in both groups which causes a delay in Fontan completion surgery.

The Fontan procedure has undergone numerous modifications since its introduction in 1971, which mirror advances in surgical and postoperative management, and is currently used to treat a broad spectrum of congenital heart diseases with a functional single ventricle.[5,17] Therefore, the highly varying patient characteristics and pathologies should be considered when assessing extubation success in patients

undergoing a Fontan operation. Heterotaxia remains an independent risk factor for morbidity following the Fontan operation despite the recent advancements in improving early and intermediate outcomes in patients.[17] Our study included four isomeric patients, including three right and one left. All of the isomeric patients were extubated in the OR.

Commonly, studies include selected and hemodynamically stable patients and unstable patients have longer mechanical ventilation times despite the encouraging results published regarding extubation in the OR in patients with Fontan completion.[5,18] Conversely, several authors have reported that early extubation is possible after total cavopulmonary connection in the majority of patients, including those who are hemodynamically unstable.[5,18] Furthermore, the extubation of unstable patients is associated with the stabilization of circulation.[18] This is a critical finding about the extubation strategy to be followed in unstable cases where transferring the patient to the ICU with mechanical ventilatory support is a common practice. None of the patients in our study required reintubation following extubations performed in the OR developed hemodynamic instability following extubation. Furthermore, 66.6% of the patients in Group 2 were extubated during the first 24 h postoperatively. Determining the exact reason for the delay in extubation is difficult because of the retrospective nature of the study. These patients did not have major differences in their perioperative parameters. Thus, we can only assume from the patient data that the oxygenation of patients was not interpreted as adequate, and the extubation was delayed until the unstable condition of the patient was resolved. This raises the question of whether the decision to proceed with ultra-fast track extubation can be made more flexible since fixed inclusion and exclusion criteria do not exist and the literature suggests extubation as a step taken in favor of patient stabilization. The consideration of unstable patients for fast track extubation could introduce a possible paradigm shift in the extubation strategy in patients with a single ventricle.

Previous studies have revealed a correlation between earlier extubation and shorter length of hospital or ICU stay following a Fontan operation.[6,18] Our study revealed no association between early extubation and hospital length of stay in our patient population. Extubation in the OR and the incidence of postoperative complications were previously reported as the two most significant indicators of the postoperative length of hospital stay.[19] This lack of association can be attributed in part to the presence of significant pleural effusions that may influence discharge times following the Fontan completion which may or may not be affected directly by early extubation.[7] Our study revealed pleural effusions in three patients, of whom two were from the group extubated in the OR. Thus, we could not reach a clear conclusion on this matter. Several studies have previously reported a lack of correlation between earlier extubation and shorter length of hospital stay, similar to our results.[4,7]

Greater flexibility has been given to cardiac anesthesiologists with the use of shorter-acting anesthetic drugs, combined with certain regional anesthesia techniques, regarding anesthetic regimens that allow this strategy during the planning of early extubation.[1,8] Pain management and sedation without respiratory depression become critical considerations for all practitioners involved, regardless of the timing of extubation in a patient.[3] The perioperative team's education and approach to early extubation and postoperative airway management is a critical component in allowing safe and successful early extubation of pediatric patients with cardiac diseases. Therefore, the success of fast track extubation in patients undergoing a Fontan operation should be viewed as multifactorial, and surgeons, anesthesiologists, and ICU specialists should closely collaborate.

This study has certain limitations. The main limitation was the small patient cohort and the retrospective design. Consequently, the study was confined to data from the medical records of patients and can only indicate correlations between variables instead of causality. The decision to proceed with on-table extubation was made using a patient-specific approach although the operative and anesthetic management of patients did not differ much between the groups.

Evidence to establish a causal relationship between early extubation and patient outcomes remains insufficient despite the increasing prevalence of early extubation strategies. Our study results reveal no clear association between perioperative variables and the success of ultra-fast track extubation. Therefore, prospective randomized trials are required to determine whether fast-tracking improves outcomes in children undergoing congenital heart surgery, as previously concluded. However, on-table extubation of patients undergoing a Fontan operation appears to be a feasible strategy.

Disclosures

Ethics Committee Approval: The study was approved by The Koç University Ethics Committee (Date: 30/12/2022, No: 2022.484.IRB1.193).

Informed Consent: Written informed consent was obtained from all patients.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

Authorship Contributions: Concept – M.B., E.Ö.; Design – M.B., K.D., S.Ç.; Supervision – M.B., E.Ö.; Materials – K.D., S.Ç., M.T., Ö.Ö., M.H.K.; Data collection &/or processing – M.B., Ş.K., M.T., Ö.Ö., M.H.K.; Analysis and/or interpretation – M.B., Ş.K.; Literature search – Ş.K.; Writing – M.B., Ş.K.; Critical review – M.B., E.Ö.

References

1. Kawaguchi A, Liu Q, Coquet S, Yasui Y, Cave D. Impact and challenges of a policy change to early track extubation in the operating room for fontan. Pediatr Cardiol 2016;37:1127–36.
2. Mutsuga M, Quiñonez LG, Mackie AS, Norris CM, Marchak BE, Rutledge JM, et al. Fast-track extubation after modified Fontan procedure. J Thorac Cardiovasc Surg 2012;144:547–52.
3. Mittnacht AJ, Hollinger I. Fast-tracking in pediatric cardiac surgery--the current standing. Ann Card Anaesth 2010;13:92–101.
4. Kintrup S, Malec E, Kiski D, Schmidt C, Brünen A, Kleinerüschkamp F, et al. Extubation in the operating room after fontan procedure: Does it make a difference? Pediatr Cardiol 2019;40:468–76.
5. Georgiev S, Balling G, Ruf B, Ackermann K, von Ohain JP, Schreiber C, et al. Early postoperative extubation of unstable patients following total cavopulmonary connection: Impact on circulation and outcome. Cardiol Young 2017;27:860–9.
6. Ovroutski S, Kramer P, Nordmeyer S, Cho MY, Redlin M, Miera O, et al. Early extubation is associated with improved early outcome after extracardiac total cavopulmonary connection independently of duration of cardiopulmonary bypass. Eur J Cardiothorac Surg 2018;54:953–8.
7. Mahle WT, Jacobs JP, Jacobs ML, Kim S, Kirshbom PM, Pasquali SK, et al. Early extubation after repair of tetralogy of fallot and the fontan procedure: An analysis of the society of thoracic surgeons congenital heart surgery database. Ann Thorac Surg 2016;102:850–8.
8. Morales DL, Carberry KE, Heinle JS, McKenzie ED, Fraser CD Jr, Diaz LK. Extubation in the operating room after Fontan's procedure: Effect on practice and outcomes. Ann Thorac Surg 2008;86:576–82.
9. Mery CM, De León LE, Trujillo-Diaz D, Ocampo EC, Dickerson HA, Zhu H, et al. Contemporary outcomes of the fontan operation: A large single-institution cohort. Ann Thorac Surg 2019;108:1439–46.
10. Tsubura M, Osaki M, Motono K, Hamamoto N. Risk factors for prolonged ventilation after the modified Fontan procedure. Cardiol Young 2022;32:969–74.
11. Kawaguchi A, Cave D, Liu Q, Yasui Y. Development of a model identifying fontan patients at high risk for failed early extubation in the operating room. Thorac Cardiovasc Surg 2016;64:44–52.
12. Lehner A, Schuh A, Herrmann FE, Riester M, Pallivathukal S, Dalla-Pozza R, et al. Influence of pulmonary artery size on early outcome after the Fontan operation. Ann Thorac Surg 2014;97:1387–93.
13. Adachi I, Yagihara T, Kagisaki K, Hagino I, Ishizaka T, Kobayashi J, et al. Preoperative small pulmonary artery did not affect the midterm results of Fontan operation. Eur J Cardiothorac Surg 2007;32:156–62.
14. Vitanova K, Shiraishi S, Mayr B, Beran E, Cleuziou J, Strbad M, et al. Impact of characteristics at stage-2-palliation on outcome following fontan completion. Pediatr Cardiol 2019;40:1476–87.
15. Meza JM, Hickey E, McCrindle B, Blackstone E, Anderson B, Overman D, et al. The optimal timing of stage-2-palliation after the norwood operation. Ann Thorac Surg 2018;105:193–9.
16. Shiraishi S, Nakano T, Oda S, Kado H. Impact of age at bidirectional cavopulmonary anastomosis on haemodynamics after Fontan operation. Cardiol Young 2018;28:1436–43.
17. Ovroutski S, Sohn C, Barikbin P, Miera O, Alexi-Meskishvili V, Hübler M, et al. Analysis of the risk factors for early failure after extracardiac Fontan operation. Ann Thorac Surg 2013;95:1409–16.
18. Ono M, Georgiev S, Burri M, Mayr B, Cleuziou J, Strbad M, et al. Early extubation improves outcome following extracardiac total cavopulmonary connection. Interact Cardiovasc Thorac Surg 2019;29:85–92.
19. Martin BJ, McBrien A, Marchak BE, Atallah J, Al Aklabi M, Mackie AS. Predicting post-fontan length of stay: The limits of measured variables. Pediatr Cardiol 2019;40:1208–16.