Original Article

Factors Facilitating the Success of Fast Endotracheal Extubation after Cardiac Surgery

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Objective: To study factors influencing fast endotracheal extubation after cardiac surgery.

Materials and Methods: A one-year retrospective cohort study conducted via hospital medical informatics, included patients aged over 15 years old that underwent elective valvular heart surgery by means of cardiopulmonary bypass under general anesthesia.

Results: Fifty-seven patients were enrolled in the present study including nine (15.8%) as fast endotracheal extubation in the operating theatre, 18 (31.6%) within eight hours postoperatively, and 30 (52.6%) non-fast endotracheal extubation eight hours after surgery. The preoperative and intraoperative factors were a younger age (p=0.018), high % left ventricular ejection function (LVEF) (p=0.023), and low creatinine level (p=0.026), as well as post cardiopulmonary bypass dexmedetomidine (p=0.01), reversal of muscle relaxant (p=0.004), and low dose dobutamine (p=0.003), respectively. However, multiple logistic regression analyses showed only two favorable factors, which were preoperative % LVEF of 60 or more (adjusted OR 11.266, 95% CI 1.700 to 74.664, p=0.012), and the intraoperative low dose dobutamine of 3 μg/kg/minute or less (adjusted OR 6.896, 95% CI 1.463 to 32.510, p=0.015). In addition, there were no significant complications.

Conclusion: The factors influencing fast endotracheal extubation were preoperative% LVEF of 60 or more and intraoperative low dose dobutamine of 3 μg/kg/minute or less.

Keywords: Cardiac surgery, Fast endotracheal extubation, Valvular heart disease

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In the old days, conventional cardiac anesthesia (CCA) was performed under long-acting opioids and muscle relaxants to provide hemodynamic stability[1,2]. By these means, both medications depressed the central nervous system, resulting in slow and shallow breathing, low oxygen, and high carbon dioxide levels in the blood as well as respiratory depression[3]. As a result, immediately after surgery, most intubated patients required continually mechanical ventilator support and oxygen therapy in an intensive care unit (ICU) lasting 6 to 12 hours[1].

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The advancement in anesthetics including short-acting opioids, hypnotics, muscle relaxants, and surgical procedure, the fast-track cardiac anesthesia (FTCA) is now applied to maintain effective peri-operative anesthesia and analgesia other than early post-operative endotracheal extubation[1-3]. Remifentail, a new ultra-short-acting opioid, provides adequate analgesia and spontaneous breathing without excessive residual respiratory depression during emergence[4-6]. Propofol, an intravenous anesthetic, or inhalational agents such as Isoflurane or Sevoflurane, allow rapid postoperative recovery[2,5]. Moreover, advanced perfusion and surgical techniques have promoted postoperative patients' consciousness and state of alert with normal body temperature, good cooperation, hemodynamic stability, as well as short ICU and hospital stays[2]. Thus, FTCA is cost effective and helps to reduce postsurgical complications such as excessive bleeding, cardiac tamponade, myocardial ischemia, low cardiac output, arrhythmias, sepsis, stroke, or acute renal failure[2]. Svircevic et al in a retrospective cohort study on 7,989 patients to compare the outcomes of patients that underwent FTCA with CCA confirmed that patients who underwent either CCA or FTCA showed insignificant differences in peri-operative morbidity and mortality[7]. Additionally, Myles et al in a systematic review of the safety and effectiveness of FTCA stated that anesthesia personnel could take endotracheal tube off patients under FTCA within eight hours[8].

However, the purpose of early ambulation is underscored by a new idea. Currently, ultra-fast-track cardiac anesthesia (UFTA) is introduced in clinical practice based on immediate postoperative endotracheal extubation in the operating room. This is appropriate for a patient undergoing a less invasive surgical procedure or shorter cardiopulmonary bypass (CPB) time with no preoperative intra-aortic balloon pump (IABP), extracorporeal membrane oxygenation (ECMO), or poor ventricular function[3,9,10]. Saad et al in a study on 52 patients that underwent open heart surgeries and were managed by the same anesthesiologist regarding UFTA and CCA claimed that patients undergoing UFTA experienced a significant reduction in the length of ICU stays without increased postoperative complications[10].

Since November 2018, a cardiac center had been setup at Sakonnakhon Hospital, a tertiary health care hospital in Northeastern Thailand that caters more than 700 patients annually. Thus, 15% or about 100 patients were on waiting lists for heart surgeries. However, with limited manpower and ICU beds, a cardiac surgeon, an anesthesiologist, a perfusionist, and a few operating nurses have found themselves overwhelmed. Mobilization and early ambulation from surgeries would help them overcome this inadequacy. Therefore, the investigators would like to study patients after heart operations under FTCA/UFTA and explore effective factors for early postoperative endotracheal extubation.

Materials and Methods

The present study was a one-year retrospective cohort study, approved by Sakonnakhon Institutional Review Board (SKHRE14/2562) and registered via Thai Clinical Trial Registry (TCTR20200418001). The inclusion criteria were male and female patients, aged over 15 years, American Society of Anesthesiology (ASA) I to IV, with valvular heart diseases and undergoing elective cardiac surgeries under CPB with general anesthesia at Sakonnakhon Hospital between November 1, 2018 and October 31, 2019. The exclusion criteria were patients with preoperative ECMO insertion, emergency cases, chronic kidney injuries with hemodialysis, left ventricular ejection function (LVEF) of less than 30%, and anesthesia-related complications.

Data were retrieved from the hospital informatics system including demographic data, surgical procedures, anesthetic management, ICU care, and medical outcomes.

The UFTA, FTCA, and non-fast track anesthesia (nFTA) are defined as the process of endotracheal extubation immediate in the operating room, within eight hours, and beyond eight hours, respectively.

The sample size was calculated from a previous literature review[11]. The various factors regarding FTCA failure, including deep sedation, confusion, excessive bleeding, and high inotropic support, were determined. Multiple logistic models implied 10 events per variable, so at least 40 events per group (FTA/nFTA) were required and the endotracheal extubation success was 49.5%.

For 49 successful events, the sample size was 100 patients.

So, for 40 successful events, the corresponding sample size: (40×100)/49=81.6 patients.

With 10% added, the sample size would then be 90 patients. Despite about 100 patients scheduled for cardiac surgeries at Sakonnakhon Hospital annually, only 82 patients were qualified for the present study.

In the operating theatre

After inserting a needle cannula to administer intravenous fluid on either forearm, an anesthesiologist placed an electrocardiogram, percutaneous pulse oximetry, and non-invasive blood pressure device on the patient for standard monitoring. Then she administered 1 to 3 LPM oxygen to the patient via an oxygen nasal cannula prior to intra-arterial cannulation, for direct arterial blood pressure monitoring, blood gas analysis, and electrolyte checking.

After pre-oxygenating the patient with 100% oxygen for two to three minutes, she titrated 0.05 to 0.1 mg/kg midazolam, 1 to 5 μg/kg fentanyl and 1 to 2 mg/kg propofol intravenously until the patient’s eyelash reflex disappeared, followed by 1 mg/kg rocuronium or 0.6 mg/kg atracurium or 0.1 mg/kg cistracurium or 0.1 mg/kg pancuronium intravenously for muscle relaxation and endotracheal intubate. Then 0.08 to 4.0 μg/ml propofol via the target-controlled infusion (TCI) with or without 0.4 to 1% isoflurane or 0.6 to 2% sevoflurane was adjusted to maintain anesthesia and stabilize the hemodynamic status. Meanwhile, the vital signs were continuously monitored.

The Surgeons performed the heart operations through median sternotomy under the CPB with antegrade, retrograde or directed cardioplegia for myocardial protection. Heparin was administered to achieve the activated clotting time (ACT) of more than 450 seconds. In addition, nasal and rectal temperature probes were placed to maintain each patient's body temperature at 32℃ to 35℃. After the CPB termination, protamine was applied to reverse the action of heparin. In addition, 0.25 μg/kg/hour dexmedetomidine would be continuously infused if contraindication such as severe bradycardia, temporary pacemaker, or high inotropic support developed.

After the surgical procedures, some patients were extubated immediately (UFTA), within eight hours (FTCA), or beyond eight hours (nFTA). All patients with oxygen administration were transferred to the ICU under the close observation of registered nurses.

Statistical analysis

The data were analyzed using PASW Statistics for Windows, version 18.0 (SPSS Inc., Chicago, IL, USA). Continuous data were expressed as mean ± standard deviation (SD) and median with the twenty-fifth (P_{25}), and the seventy-fifth percentile (P_{75}). Categorical data were presented as numbers and percentages. To test the difference in quantitative variables with and without normal distribution between FTA and nFTA, a 2-sample t-test and a Mann-Whitney U test were applied, respectively. Pearson's chi-square test or Fisher's exact test was used to test qualitative variable differences between the two groups. The LVEF cut-off point and dobutamine dosage were determined by the receiver operating characteristic curve (ROC) and the area under the curve (AUC). Binary logistic regression was used to estimate the crude and adjusted odds ratio of a successful FTA response. Criteria for predictor or independent variable selection for multivariate analysis were p-values in univariate of less than 0.05 with the enter method. A 2-tailed p-value of less than 0.05 was considered statistically significant.

Results

Only 57 patients were enrolled in the present study, since eight were emergency cases, three had % LVEF of less than 30, four required hemodialysis, six developed intraoperative complications, and two had incomplete anesthetic records. Fast-track anesthesia (FTA), including UFTA and FTCA, comprised nine (15.8%) and 18 (31.6%) patients, respectively, while the nFTA covered 30 (52.6%) patients. The FTA and nFTA were compared for factors promoting the success of endotracheal extubation.

Preoperatively, the young age group of 49.9±16.6 and 59.1±12.0, p=0.018; the high % LVEF of 64.0 (61.0, 67.0) and 59.5 (51.5, 65.0), p=0.023; and the low creatinine level of 0.8 (0.6, 1.0) and 1.0 (0.9, 1.1), p=0.026. These showed statistical significance (Table 1).

Intraoperatively, post-CPB dexmedetomidine of 23 (85.2%) and 16 (53.3%), p=0.01, reversal of

Table 1. Patients' demographic characteristic

Variable	FTA (n=27); n (%)	nFTA (n=30); n (%)	p-value
Age (year); mean±SD	49.9±16.6	59.1±12.0	0.018*
Body weight (kg); mean±SD	59.56±11.7	57.27±12.1	0.47
Height (cm); median (P_{25}, P_{75})	161.0 (155.0, 172.0)	160.0 (152.3, 165.0)	0.336
BMI (kg/m^2); median (P_{25}, P_{75})	21.6 (19.7, 25.0)	22.0 (19.9, 24.6)	0.917
Sex			0.843
Male	16 (48.5)	17 (51.5)	
Female	11 (45.8)	13 (54.2)	
ASA classification			0.492
III	27 (49.1)	28 (50.9)	
IV	0 (0.0)	2 (100)	
% LVEF; median (P_{25}, P_{75})	64.0 (61.0, 67.0)	59.5 (51.5, 65.0)	0.023*
≥60	22 (81.5)	15 (50.0)	0.013*
Hemoglobin (g/dL); mean±SD	12.15±2.1	12.42±2.2	0.63
Hematocrit (%); mean±SD	37.0±5.3	37.0±5.6	0.98
Creatinine (mg/dL); median (P_{25}, P_{75})	0.8 (0.6, 1.0)	1.0 (0.9, 1.1)	0.026*
EKG			0.132
NSR	13 (61.9)	8 (38.1)	
AF	11 (35.5)	20 (64.5)	
Others	3 (60.0)	2 (40.0)	
Fc			0.673
I	25 (50.0)	25 (50.0)	
II	2 (33.3)	4 (66.7)	
III	0 (0.0)	1 (100)	
Valvular disease			0.26
Single valve	21 (77.8)	17 (56.7)	
Double valves	5 (18.5)	11 (36.7)	
Triple valves	1 (3.7)	2 (6.7)	

FTA=fast-track anesthesia; nFTA=non-fast track anesthesia; BMI=body mass index; ASA=American Society of Anesthesiology; LVEF=left ventricular ejection fraction; EKG=electrocardiogram; NSR=normal sinus rhythm; AF=atrial fibrillation; Fc=New York Heart Association Functional Classification; SD=standard deviation

* p<0.05 statistical significance

Table 2. Intraoperative data

Variable	FTA; n (%)	nFTA; n (%)	p-value
Valvular surgery			0.459
Single	21 (77.8)	19 (63.3)	
Double	5 (18.5)	9 (18.5)	
Triple	1 (3.7)	2 (6.7)	
Anesth time (minute); mean±SD	247.41±45.79	269.37±58.19	0.122
Operative time (minute); mean±SD	195±41.51	206.67±60.12	0.506
CPB time (minute); mean±SD	95.73±31.7	109.67±39.2	0.27
Ischemic time (minute); mean±SD	67.93±28.2	81.73±36.2	0.224
Finished time (minute); mean±SD	76.89±10.9	81.83±20.6	0.571
Fentanyl (μg/kg); mean±SD	8.78±1.82	8.81±2.43	0.565
Morphine (mg/kg); mean±SD	0.13±0.07	0.10±0.08	0.185
TCI-propofol	27 (100)	28 (93.3)	0.492
Dexmedetomidine	23 (85.2)	16 (53.3)	0.01*
Midazolam (mg/kg); mean±SD	0.097±0.04	0.098±0.04	0.373
Reversal	9 (33.3)	1 (3.3)	0.004*
Muscle relaxant pre-CPB			0.239
Rocuronium	27 (100)	27 (90.0)	
Pavulon	0 (0.0)	3 (10.0)	
Muscle relaxant during CPB			0.141
None	1 (3.7)	0 (0.0)	
Rocuronium	4 (14.8)	1 (3.3)	
Nimbex	0 (0.0)	1 (3.3)	
Pavulon	22 (81.5)	28 (93.3)	
Muscle relaxant post CPB			0.127
None	19 (70.4)	24 (80.0)	
Rocuronium	4 (14.8)	0 (0.0)	
Nimbex	1 (3.7)	2 (6.7)	
Atracurium	3 (11.1)	2 (6.7)	
Pavulon	0 (0.0)	2 (6.7)	
Last dose of muscle relaxant (minute); median (P_{25}, P_{75})	150.0 (105.0, 175.0)	171.0 (97.5, 195)	0.429
Postoperative inotropic/vasopressor			
Dobutamine (μg/kg/minute); median (P_{25}, P_{75})	1.0 (0, 2)	3.0 (1, 5.3)	0.003*
• ≤3	23 (85.2)	13 (43.3)	0.001*
Nitroglycerine (μg/kg/minute); median (P_{25}, P_{75})	1 (0, 1.5)	1 (0, 1.1)	0.934
Dopamine			1
• No	27 (100)	29 (96.7)	
• Yes	0 (0.0)	1 (3.3)	
Norepinephrine			1
• No	26 (96.3)	29 (96.7)	
• Yes	1 (3.7)	1 (3.3)	
Milrinone			1
• No	27 (100)	29 (96.7)	
• Yes	0 (0.0)	1 (3.3)	
Adrenaline			0.239
• No	27 (100)	27 (90.0)	
• Yes	0 (0.0)	3 (10.0)	
Intraoperative adverse events			
Arrhythmia	6 (22.2)	9 (30.0)	0.506
Bleeding	0 (0.0)	2 (6.7)	0.492
Low CO	0 (0.0)	1 (3.3)	1

FTA=fast-track anesthesia; nFTA=non-fast track anesthesia; CPB=cardiopulmonary bypass time; Ischemic time=aortic cross-clamp time; TCI-propofol=target controlled infusion of propofol; Reversal=reversal of muscle relaxant at the end of the surgery; Dexmedetomidine=continuously intravenous infusion of 0.25 μg/kg/hour at post-CPB peroid; Finished time=duration from the end of CPB to the end of the operation, Last dose of muscle relaxant=Last dose of muscle relaxant to the end of the surgery; SD=standard deviation

* p<0.05 statistical significance

muscle relaxant of 9 (33.3%) and 1 (3.3%), p=0.004, and dobutamine requirement of 1.0 (0, 2) and 3.0 (1, 5.3), p=0.003. These also showed statistical significance (Table 2).

However, complications between the FTA and nFTA showed no significant differences (Table 3).

Those significant variable differences between the two groups by the univariate analysis were considered risk factors for a successful FTA (Table 4). The independent risk factors showed statistical significance when the% LVEF was greater than or equal 60 (adjusted odds ratio 11.266, 95% CI 1.700, 74.664, p=0.012), and postoperative dobutamine was less than or equal 3 μg/kg/minute (adjusted odds ratio 6.896, 95% CI 1.463, 32.510, p=0.015).

The cut-off point of the ROC curve of% LVEF at 60 (sensitivity 81%, specificity 50%, and accuracy of prediction 67%) and that of the postoperative low

Table 3. Postoperative complications

Variable	FTA; n (%)	nFTA; n (%)	p-value
Cardiac event	5 (18.5)	7 (23.3)	0.656
Re-sternotomy	0 (0.0)	0 (0.0)	N/A
Neurological complication	0 (0.0)	1 (3.3)	1.000
Reintubation	1 (3.7)	1 (3.3)	1.000
Delirium	0 (0.0)	3 (10.0)	0.239
AKI	3 (11.1)	6 (20.0)	0.476
Awareness	0 (0.0)	0 (0.0)	N/A
Status			0.492
Discharge	27 (100)	27 (90.0)	
Refer	0 (0.0)	2 (6.7)	
Dead	0 (0.0)	1 (3.3)	
LOS (days); median (P_{25}, P_{75})	8 (7, 10)	10 (7, 12.25)	0.081

FTA=fast-track anesthesia; nFTA=non-fast track anesthesia; AKI=acute kidney injury; LOS=length of hospital stays; N/A=not available

* p<0.05 statistical significance

Table 4. Risk factors associated with ultra/fast tract extubation from multiple logistic regression analyses

Baseline	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age (year)	0.954 (0.915 to 0.994)	0.026	0.966 (0.914 to 1.022)	0.229
LVEF ≥60%	4.400 (1.317 to 14.700)	0.016	11.266 (1.700 to 74.664)	0.012*
Cr	0.139 (0.015 to 1.258)	0.079	0.265 (0.016 to 4.436)	0.356
Dexmedetomidine	5.031 (1.397 to 18.120)	0.013	0.226 (0.044 to 1.155)	0.074
Reversal	14.500 (1.692 to 124.239)	0.015	0.056 (0.003 to 1.061)	0.055
DOB ≤3µg/kg/minute	7.519 (2.082 to 27.154)	0.002	6.896 (1.463 to 32.510)	0.015*

LVEF=left ventricular ejection fraction; Cr=creatinine; Reversal=reversal of muscle relaxant at the end of the surgery; DOB=dobutamine; OR=odds ratio; CI=confidence interval

* p<0.05 statistical significance

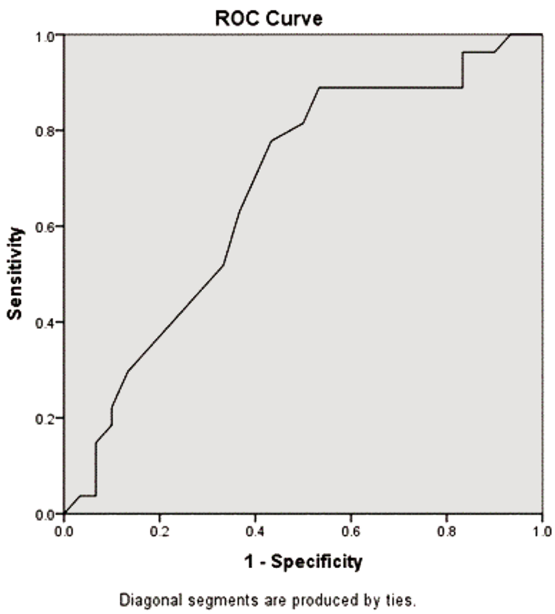

Figure 1. The ROC curve of LVEF.

AUC=67%, p=0.023, 95% CI 0.534 to 0.817

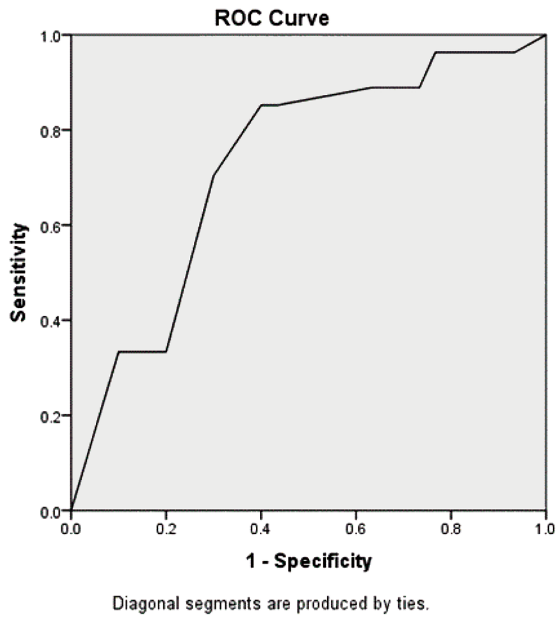

Figure 2. The ROC curve of dobutamine.

AUC=72.8%, p=0.003, 95% CI 0.594 to 0.862

dobutamine at 3 µg/kg/minute (sensitivity 85%, specificity 56%, and accuracy of prediction 73%) are illustrated in Figure 1 and 2.

Discussion

The present retrospective cohort study on 57 patients comprising of FTA (n=27) and nFTA (n=30) cases were investigated for factors affecting the success of endotracheal extubation. It was found that the preoperative and intraoperative issues were the high LVEF and the low dosage of dobutamine. Young age, low creatinine levels, post-CPB dexmedetomidine, and the reversal of muscle relaxants as well as complications between the two groups appeared irrelevant to the subject.

By and large, the ejection fraction (EF) implies contractility of the heart and the wall tension in the left ventricle. It contributes to modest cardiac outputs, myocardial oxygen consumption, and organ perfusion. As blood pressure (BP) is defined by the cardiac output (CO) times the systemic vascular resistance (SVR) + right atrial pressure (RA), while the cardiac output (CO) is defined by the stroke volume (SV) times the heart rate (HR), patients with high LVEF and mild inotropic support experienced dramatic improvement in left ventricular function[12]. This improvement reduced patients' risk during surgeries and postoperative periods. Thus, patients with LVEF of more than 55% and low dose inotrope should have good physiological cardiac reserves, resulting in early endotracheal extubation and ambulation.

This agreed with Zakhary et al[13] in a retrospective study on independent risk factors for fast-track failures using a predefined fast-track protocol in preselected cardiac surgery patients, who concluded that the independent risk factors for fast-track failures were age of more than 70 years, female, prolonged surgery, and prolonged cross-clamp time. They claimed that patients with or without low-dose vasopressor or inotropic support with continuous infusion of less than 0.1 mg/kg/minute of norepinephrine or less than 0.05 mg/kg/minute of epinephrine, and no clinical signs of bleeding could be transferred to the post-anesthetic care unit (PACU).

Akhtar et al[11] in a prospective observational study on the success and failure of fast track extubation in cardiac surgery patients of tertiary care hospital, advocated that the common reasons for delayed extubation included deep sedation 46.5%, confusion 25%, excessive bleeding 11.3%, and high inotropic support 5.68%. In addition, London et al[14] mentioned the use of inotrope in an investigation on a retrospective study involving 304 cardiac surgical patients on a fast-track clinical pathway in which early extubation was defined as extubation in 10 hours or less. They stated that the preoperative factor was age and the intraoperative factors, which were the sufentanyl or fentanyl dose, inotrope use, and platelet transfusion. In addition, the use of arterial graft was identified as independent predictors of delayed extubation.

Good heart contractility appeared to guarantee the success of early extubation. Borracci et al[15] in a study on operating room extubation as ultra-fast-track anesthesia, in patients undergoing on-pump and off-pump cardiac surgeries, stated that patients undergoing on-pump surgeries with antecedents of heart failure or difficult cardiopulmonary by-pass weaning should not be extubated in the operating room. By the same token, immediate extubation should be avoided in obese patients with hemodynamic compromise during off-pump coronary bypass surgeries. This was confirmed by Reyes et al[16] in a study on early versus conventional extubation after cardiac surgeries with CPB that the preoperative and operative variables relating to successful early extubation were a younger age, a smaller proportion of redo operation, lower risk score, and shorter bypass and cross-clamping time.

Though the younger age, creatinine level, post dexmedetomidine, and reversal of muscle relaxants appeared irrelevant to the subject, there were studies conducted on them.

Subramaniam et al[17] in an investigation of 1,518 patients in a retrospective cohort study that underwent standardized fast-track cardiac anesthetic protocol during adult cardiac surgeries claimed that a younger age, a lower body mass index, a higher preoperative serum albumin, an absence of chronic lung disease and diabetes, a less-invasive surgical approach, an isolated coronary bypass surgery, an elective surgery, and lower doses of intraoperative intravenous fentanyl were independently associated with a higher probability of operating room extubation.

Dorsa et al[18] in a study on 1,196 patients that underwent off-pump coronary artery bypass surgeries found that preoperative predictors for immediate extubation failures included previous renal failures, cardiac reoperation, and preoperative IABP placement.

Suraseranivong et al[19] in a study of the association between age factors, and extubation failures in elderly patients concluded that patients with extubation failures had lower body temperatures and higher Facial Anxiety Scale (FAS) scores with significantly higher levels of blood urea nitrogen, serum sodium, and serum calcium and wider anion gaps.

Of particular interest, dexmedetomidine, a highly selective α2 adrenergic agonist, provides a unique quality of conscious sedation that resembles natural sleep, which does not result in respiratory depression and minimizes the effects of hemodynamic instability. It is a central acting sympatholytic, sedation, analgesic, and amnestic[20-22]. Geng et al[23] in a meta-analysis on the influence of perioperative dexmedetomidine on patients undergoing cardiac surgeries revealed that dexmedetomidine reduced the risk of postoperative ventricular tachycardia, atrial fibrillation, delirium, and shorten the ICU stays.

However, post-CPB dexmedetomidine showed no evidence of the success of endotracheal extubation, contradicting Karaman et al[20] in the study on effects of dexmedetomidine and propofol on sedation in patients after coronary bypass graft surgeries in fast-track recovery room settings. They concluded that dexmedetomidine had significant advantages of shorter extubation time and higher postoperative patient satisfaction scores. In addition, Menda et al[24] in the study on dexmedetomidine as an adjunct to anesthetic induction to attenuate hemodynamic response to endotracheal intubation in patients undergoing fast-track CABG, concluded that dexmedetomidine could safely be used to attenuate hemodynamic responses to endotracheal intubation in patients undergoing myocardial revascularization while receiving beta blockers.

Normally, the use of long-acting muscle relaxants is associated with delayed neuromuscular recovery, residual block, and late recurarization in PACU. Thus, the use of short-acting muscle relaxants, reversal and neuromuscular monitoring becomes the main concern in cardiac surgeries. The FTCA protocol also advocates for short or intermediate acting of muscle relaxants because during cardiac surgeries when adequate anesthesia is provided, there is no need for continuous neuromuscular blockade[25-28].

This was supported by Murphy et al[25] in the study on the recovery of neuromuscular function after cardiac surgeries, who suggested that the use of longer-acting muscle relaxants was associated not only with impaired neuromuscular recovery, but also with signs and symptoms of residual muscle weakness in the early postoperative period. Nevertheless, in a survey of the use of neuromuscular-blocking drugs in adult cardiac surgeries, they demonstrated that long-acting muscle relaxants were often administered to fast-track cardiac patients with the rare use of peripheral nerve stimulator monitoring and infrequent administration of the reversal.

Additionally, Roy et al[26] in a case report and prospective observational study on postoperative awake paralysis in the ICU after cardiac surgeries due to residual neuromuscular blockade suggested that muscle relaxants should not be administered after intubation in fast-track patients, but if given, the assessment of neuromuscular functions prior to extubation was crucial. Gueret et al[27] in the study on the necessity of muscle relaxants for cardiac surgeries, concluded that a single dose of either atracurium or cisatracurium was sufficient to provide efficient paralysis from the start of induction leading to quicker recovery from paralysis in fast-track cardiac surgeries. And Fakhari et al[28] in a randomized clinical trial on anesthesia in adult cardiac surgery without maintenance of muscle relaxants, indicated no need for muscle paralysis during cardiac surgeries when adequate anesthesia was provided, however, it could increase intra-operative patient movement risk.

Given the present study's limitations, the number of patients was small. The investigators could not determine all causal relations regarding early postoperative endotracheal extubation after cardiac operations under FTCA/UFTA.

Conclusion

After cardiac operations under FTCA/UFTA, the effective factors regarding early postoperative endotracheal extubation were the high LVEF and the low dosage of dobutamine, respectively, while the younger age, low creatinine level, post-CPB dexmedetomidine, and the reversal of muscle relaxant appeared irrelevant to the subject.

What is already known on this topic?

Endotracheal extubation immediately after cardiac operations has proven standard surgical care, for patients' safety and potential benefit with remarkably reduced postoperative ventilator support and cardiorespiratory morbidity and mortality.

What this study adds?

The factors promoting the success of endotracheal extubation were high LVEF and low dosage of dobutamine, while the young age, low creatinine level, post-CPB dexmedetomidine, and reversal of muscle relaxants as well as complications between the two groups appeared irrelevant.

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Conflicts of interest

The authors declare no conflict of interest.

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