SPECIAL ARTICLE

Early extubation in adult and pediatric open heart surgery; an experience from a tertiary care hospital of a developing country

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ABSTRACT
Numerous remarkable advances have been made in the perioperative care of both adults and children undergoing cardiac surgery. Improvements in the technology of CPB, advances in the techniques of surgery, a better understanding of the pathophysiology of the postoperative period, and refinements in anesthetic and ICU care have led to changes in the perioperative management of these patients. These changes have resulted in improved outcomes and shortened hospital stay. Fast track strategy (FTS) is one of the major advances in the sub-speciality of cardiac anesthesia practice. FTS is applicable to all moderate to low risk elective open heart adult and pediatric surgeries. The role of anesthesiologist in Fast Track extubation (FTE) is very crucial and decisive as perioperative physician. Teamwork in FTE execution is very important. Every team member should respect the opinion of other team member provided the opinion is in the best interest of the patient. Multiple studies conducted as clinical audits and case series to validate the safety and feasibility of fast track extubation in adult and pediatric open heart surgical patients at our institution. Fast track extubation was practically evolved at our institution in 2007. FTE cannot be predicted in all the cases as it depends upon intra-operative and post-operative course. Safety is the priority in the decision about fast track extubation.

Key words: Early Extubation; Open Heart Surgery; Tertiary care hospital; adult; Pediatric

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INTRODUCTION
Numerous remarkable advances have been made recently, both in the adult and pediatric cardiac surgery. Improvements in Cardiopulmonary Bypass (CPB) machines and surgical techniques, a better understanding of the pathophysiology of disease, refinements in anesthetic techniques and Critical Care have led to better outcome and shortened hospital stay. Fast track strategy (FTS) is one of the major advances in the sub-speciality of cardiac anesthesia practice. FTS is applicable in all moderate to low risk elective open heart adult and pediatric surgery.

Fast tracking was first introduced in adult cardiac surgery as a response to growing economic pressure in the United States in 1977 by Ott and colleagues.1 Early extubation, early ambulation, cardiac rehabilitation and early discharge are the four components of Fast track strategy

Fast track extubation (FTE) is the foundation stone of Fast track strategy in cardiac surgery and FTE is now a standard of care practice in adult and pediatric open-heart surgery.

The advantages of early extubation have been validated and2 investigators4–5) have developed a clinical pathways for safe and efficient approach for...
early extubation in open heart surgery

these patients. The prime objective of most studies was to establish a quick uncomplicated recovery pathway with minimal burden on the Critical Care Units (ICU). Different study outcomes have been used to determine the success of these pathways. Most investigators have concentrated on ventilation time, length of ICU and hospital stay and postoperative complications as the main outcome measures to validate success of fast-track strategy. Fast track extubation is a very safe practice in pediatric CHD surgical patients belonging to RACHS-1 category 1, 2 and 3 and this has been proven by various national and international studies. Fast track and ultra fast track extubation after pediatric open-heart surgery does not affect cardiac function. This practice is safe and feasible if applied with multi-disciplinary approach. Fast track extubation is practical in the scenario of developing countries with limited health care resources. The primary objectives of fast track extubation for developing countries is cost effectiveness, reduction in ventilator-associated complications, better utilization of limited resources and patients own and the family mental satisfaction. Patient’s relatives feel satisfied when they see their patient conscious, awake and without ventilator support. Protocols are meant to address issues before they occur. Institution specific protocols should be implemented to standardize systematic plans for weaning patients and managing issues to facilitate early ICU and hospital discharge. The protocols should involve all members of perioperative care team before implementation and should be tailored according to the situation for best patient centered outcome.

Protocols for Early Extubation in Open Heart Surgery:

Fast track extubation means extubation within 4-8 hours of arrival in the Cardiac Intensive Care unit (CICU). An expeditious version of fast track extubation is ultra-fast track or on table extubation being executed in the operating room (OR) shortly after end of surgery especially in pediatric CHD surgical patients.

Fast Track extubation is made possible due to choice of better anesthetic techniques using short acting anesthetic medications, better surgical techniques with improved efficiency, and better perfusion techniques with less inflammatory response supplemented by myocardial protection. Trans Esophageal Echocardiography (TEE) is used to confirm accuracy of surgical correction. Improved post-operative multidisciplinary ICU care with better objective and subjective monitoring is also used.

The role of anesthesiologist in FTE is crucial and decisive as a perioperative physician. It pivots around the decision regarding selection of premedication, intra-operative anesthetic agents, post-operative analgesia strategy and pharmacological intervention to reduce or avoid post-operative nausea and vomiting.

Protocols are based upon certain selection criteria in which moderate to low risk open-heart surgery patients are included after pre-operative anesthetic assessment. Goal oriented pre-operative assessment is an important factor in the selection of correct patients in which fast track extubation is applicable. The general inclusion criteria for adult fast track extubation being followed are patients undergoing elective open heart surgery, between the ages of 18 -75 years with mild (40-50% ejection fraction) to moderate (EF 30-40%) left ventricular (LV) dysfunction. Exclusion criteria are patients with severe LV dysfunction (EF < 30%, pre-operative Intra-aortic balloon pump (IABP) and dialysis dependent renal failure.

Communication with all the team members including CICU staff and intensivist has been emphasized. A communication form of the open heart surgery patient is sent to the CICU with detailed information about demographics, diagnosis, procedure, the tentative plan about the post-operative care mentioning ventilatory settings, monitoring, inotropes and fast track or conventional extubation. This pre-emptive communication is meant to make the CICU nursing staff prepared to address potential issues.

Fast track anesthesia constitutes anesthesia induction using low doses of fentanyl (3-8 μg/kg), propofol (1-2 mg/kg), and rocuronium (0.5-1 mg/kg). Anesthesia is maintained by using isoflurane (1 minimum alveolar concentration), with propofol infusion during Cardiopulmonary Bypass (CPB) at a rate of 2 mg/kg/h. Bispectral index monitoring (BIS) is also utilized in patients to titrate the depth of anesthesia. After CPB, recruitment maneuvers are used to prevent atelectasis. Warming devices are part of the plan to prevent hypothermia. Following closure of sternum, the anesthetic depth is reduced to allow the patient to initiate ventilation and then weaned to a pressure-assist mode before transfer.
to CICU. In the CICU, the patient is rewarmed to a temperature of 36 °C with assistance of warming blanket. He/She is assessed for chest tube output, arterial blood gases ABGs and hemodynamic parameters for two hours in order to make a decision regarding weaning from ventilator. After two hours of post-operative assessment weaning is initiated if the patients fulfills the weaning criteria. Patient ventilatory support is reduced under guidance of ABGs and biochemical status. Sedation is terminated after the patient initiates spontaneous breathing in addition to SIMV breaths. Weaning steps followed are reduction in FIO2 to 0.4, lowering PEEP if > 5 cm, decreasing SIMV to switch to spontaneous mode, decreasing pressure support (PS) to 8-10 cmH2O and monitoring Rapid Shallow Breathing Index (RSBI).

Exubtation criteria are based upon full Glasgow Coma Score (GCS), ability to cough and clear secretions, no airway edema, chest tube output < 100 ml/hour for two consecutive hours, stable hemodynamic parameters and normal oxygenation/ and ventilation.

In pediatric open-heart surgical patients, chest tube output should be less than 2 ml/kg/hr for two consecutive hours and patients are rewarmed to 36 °C to allow weaning from elective positive pressure ventilation.

In pediatric patients planned for on table extubation with team decision, muscle relaxation is stopped at the end of chest wiring, analgesia optimized with IV paracetamol and chest wound is infiltrated with local anesthetic solution. Anesthesia is terminated after skin closure and dressing. The patient is put on spontaneous breathing, muscle relaxation is reversed after assessment with twitch monitor (with Train of four ratio > 0.9). The patient is then extubated after fulfilling the standard extubation criteria12 shifted to CICU with supplemental oxygen, invasive arterial line, and CVP monitoring in addition to standard non-invasive American Society of Anesthesiology (ASA) monitoring.

In 1990s, due to increased demands for cardiac surgery and high healthcare costs, physicians were pressurized to reduce resource consumption and attention was focused on decreasing the length of CICU stay. Several institutions began to manage selected cardiac surgery patients in a specialized recovery unit in order to prevent ICU stay altogether. In several institutions specialized units called Enhanced Step-Down or PACUs with trained nurses are available who are trained in focused FTE.10 The patients planned for FTS are transferred there with an aim of shifting to a regular nursing unit as soon as possible. Some investigators have even implemented ambulatory cardiac surgery programs for low risk open-heart surgery.

Teamwork in Fast Track extubation execution is very important. Every team member should respect the opinion of other team member provided the opinion is in the best interest of the patient care and outcome. Each team should know their domain, decided with mutual understanding. Any input, should be informed input, this is important for mutual trust and positive outcomes.

**OUR EXPERIENCE OF FTE**

Multiple clinical audits and case series have validated the safety and feasibility of fast track extubation in adult and pediatric open-heart surgical patients at our institution the Aga Khan University Hospital. Fast track extubation was practically evolved at our hospital in 2007. A prospective observational study was done to assess the success and failure of fast track extubation in elective CABG adult surgical patients and to look for the reasons of delayed extubation.11 All elective CABG surgery patients, with EF > 40 percent were included. Patients with IABP, chronic renal failure, respiratory compromise and on high inotropic support were excluded from this audit. Six hundred and fourteen patients underwent CABG surgery during the audit period, out of which 388 (63.19%) were planned for FTE. A total of 196 (49.5%) patients could be extubated within six hours of arrival in the cardiac ICU. Common reasons for delayed extubation were deep sedation in 46.5%, confusion 25%, excessive bleeding in 11.3% and high inotropic support in 5.68%. Major contributing factors for delayed extubation were identified in this audit and specific strategies were put in place for modifications in intra operative management.

Another prospective observational study with the objective of determining the safety profile of fast track extubation practice in terms of its success and reasons for its failure in adult open-heart surgical patients was conducted at our institution.12 Primary outcome measures in the selected patients were time of extubation, re-intubation within 24 hours of extubation and total ICU stay. A total of 290 adult elective cardiac surgery patients undergoing isolated CABG, isolated valve replacements, combined procedures and aortic root replacements were enrolled. A standardized anesthetic technique was adopted. Surgical and bypass techniques were
Early extubation in open heart surgery tailored according to the procedure. Overall success rate of fast track extubation practice (extubation within 6 hours) was 51.9%. Major reasons for failed fast track extubation were hemodynamic instability, drowsiness and bleeding. Re-intubation rate was 0.68%. Average duration of CICU stay was significantly higher (51.9±17.03 hours) in cases that were extubated after 6 hours in comparison with fast track patients in which the ICU stay was 41.02±10.9 hours (P value = 0.0005). This study again reinforced the safety of fast track extubation. It was concluded that to implement the practice in its full capacity and benefit, a fast track protocol needed to be devised to standardize the practice.

Another study in our institution was conducted in Pediatric CHD surgery patients to assess the safety profile of FTE. This was a prospective observational study. A total of 71 pediatric patients (6 months to 18 years) were enrolled in the study. Standardized technique was employed and the same surgeon performed surgery on all patients. Surgical procedures included VSD closures 25(35.2%), Tetralogy total corrections 17 (23.9%), 14 (19.7%) ASD closures, Glenn shunts 4 (5.6%) and BT shunts 4 (5.6%). In twenty six patients (36.62%) the trachea was extubated in the operating room, 29 (40.85%) were extubated within 6 h of arrival in CICU. We were unable to extubate 16 (22.54%) patients due to multiple reasons. Overall success rate for fast track extubation was 77.47%. Main reasons for delayed extubation were excessive bleeding in 5 (31.3%) cases, hemodynamic instability in 4 (25%) cases and respiratory complication in 2 (12.5%). There was no re-intubation in the FTE cases. On the basis of this audit, it was recommended to use FTE in selected pediatric CHD surgical patients using a multidisciplinary approach.

Another retrospective audit was done to assess the safety of On Table Examination after open heart surgery in children with the primary objective of assessment of the rate of postoperative complications. All pediatric congenital heart surgery patients who underwent open-heart surgery between January 2011 and June 2013 were included. Incidence of immediate postoperative complications including re-intubation, significant bleeding, low cardiac output syndrome, and arrhythmias in PICU were analyzed. Surgeries included: ventricular septal defect (47%, n = 39), followed by atrial septal defect (36%, n = 30), and TOF (15%, n = 12). Cardiopulmonary bypass and aortic cross clamp time were 72.3 ± 54.2 and 47.3 ± 27.8 minutes, respectively. The mean inotrope score was 2.66 ± 3.53. There was no mortality in the cohort, whereas 97.8% (n = 80) had no complications during PICU stay. One patient (1.1%) required re-intubation for respiratory failure and one patient (1.1%) had arrhythmia that was medically managed. The mean length of PICU stay was 1.77 ± 0.985 days. As a result of this audit it was concluded that On-table extubation in children after open-heart surgery was feasible and safe in selected group of patients. No major complications were observed in the PICU.

After the success of fast track extubation in pediatric CHD surgical patients, feasibility and safety of on table extubation was assessed in TOF total correction surgical patients. For several years it was standard practice to electively ventilate these patients in the post-operative period, but a paradigm shift is taking place towards early extubation in these patients. This is due to advancement and understanding of the negative impact of positive pressure ventilation in patients with right ventricular dysfunction. A case series was documented to determine the safety and feasibility of OTE in elective TOF total correction cardiac surgical patients with an integrated team approach. A total of eight elective TOF patients were included in the series. Standardize anesthetic, surgical and perfusion techniques were used. All patients were extubated in the operating room safely. Apart from better surgical and bypass techniques, the most important factor leading to successful OTE was excellent analgesia. On the basis of the case series results, it was suggested to extubate selected TOF cardiac surgery repair patients on table safely with integrated multidisciplinary approach.

CONCLUSION

FTS is teamwork based upon anesthetic technique, surgical expertise, perfusion optimization and postoperative nursing care. Each component is very important and complements each other. Success is dependent upon careful selection of the correct patients, follow them intra-operatively and decide postoperatively about the safety and feasibility of FTE/OTE execution on the basis of objective criteria. FTE cannot be predicted for sure. It depends upon intra-operative and post-operative course. Safety is the priority in the decision about fast track extubation.

Conflict of interest: None

Authors’ contribution: Both author took equal part in the concept, data search and manuscript preparation and reviewing
REFERENCES


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