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Review Article

Fast-track anaesthesia in cardiac and transplant surgeries- An Indian perspective

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ABSTRACT

Fast-track anaesthesia (FTA) involves early tracheal extubation after surgery, ranging from extubation on-table to within 6-8 hours postoperatively.
It is associated with reduced length of intensive care and hospital stay and fewer postoperative complications, which lead to cost savings for patients and more efficient use of resources for hospitals. Despite the extensive literature on the safety and advantages of FTA in cardiac and transplant surgeries worldwide, its implementation in India is highly variable. Moreover, literature on the use of FTA in India is also scarce. Standardised protocols, appropriate selection of patients potentially suitable for FTA, and multidisciplinary collaboration are essential to ensure the wider adoption and success of FTA in India.

1. Introduction

Fast-track anaesthesia (FTA) involves early extubation within 6-8 hours after surgery.[1,2] It is necessary to achieve early patient mobility to cater to the increasing turnover of patients undergoing cardiac surgery and requiring intensive care unit (ICU) care. This has led to an increased interest in fast-track cardiac anaesthesia protocols.[3] Furthermore, the concept of ultra-fast track anaesthesia (UFTA) has emerged, wherein extubation is performed immediately or within 1 h after surgery in the operating room.[2] The Enhanced Recovery After Surgery (ERAS) guidelines for perioperative care in cardiac surgery recommend early extubation within 6 hours of ICU arrival after surgery. This is also because prolonged intubation is associated with ventilator-associated pneumonia (VAP) and significant dysphagia. ERAS guidelines suggest that FTA is safe even in high-risk patients and reduces length of stay (LOS) in the ICU and hospital and reduces costs.[4] Various studies have reported several advantages of FTA, such as shorter duration of postoperative mechanical ventilation, decrease in the incidence of VAP, shorter ICU and hospital LOS, and even mortality.[2,5,6] A previous study showed that liver transplantation recipients did not always need ICU care after surgery.[7] A 2016 Cochrane systematic review of adults undergoing cardiac surgery reported that fast-track cardiac anaesthesia (FTCA) reduced ICU stay with no significant difference in mortality rate or major complications between patients managed under FTCA protocols and conventional protocols. It concluded that FTCA is safe for low or moderate-risk patients.[8] The safety of FTCA was also reported in a study of 7989 patients undergoing cardiac surgery, which showed no evidence of an increased risk of adverse outcomes with the FTCA protocols.[9]

However, adequately powered, prospective clinical trials on FTA with mortality as a primary end-point are scarce.[10] Concerns such as the impact of optimal extubation time on LOS after cardiac surgery and the applicability, quality,

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and safety of FTCA continue to be debated.3 Similarly, in transplant surgeries, FTA is not universally accepted, and its safety continues to be debated.[7]

Two separate meetings were held with Indian experts in cardiac anaesthesia and transplant anaesthesia, to share their experiences regarding FTA and discuss the current practices and challenges in the implementation of FTA in India. Both groups of experts present their opinions in this paper, along with a review of the literature.

2. Patient Profiles Suitable for FTA

Experts in cardiac anaesthesia follow the American Society of Anesthesiologists (ASA) physical status criteria to identify patients for whom FTCA can be considered. Those with ASA I and II are considered safe for FTCA. Some experts also use EuroSCORE. The final decision on the implementation of FTA depends on the patients' preoperative condition and hemodynamic stability during the first hour of surgery. It has been reported that patients with low co-morbidity scores undergoing less complicated surgery can be considered for FTCA.[5] Additionally, those undergoing a first elective coronary artery bypass graft (CABG) or valvular surgery and having good left ventricular function, no history of myocardial infarction (MI) within 30 days before the surgery, and no systemic disease like renal failure or chronic obstructive pulmonary disease can be considered for FTCA.1 A low EuroSCORE is also a predictor of successful FTCA.[11]

According to cardiac anaesthesia experts, most patients can be considered for FTA except those with compromised airways. Of all patients undergoing solid renal transplants, 60%-70% are usually found suitable for FTA; however, the percentage for those undergoing liver transplants is much lower. Other factors considered when assessing the feasibility of FTA include cardio-respiratory parameters, hemodynamic stability, and ASA grading. Perioperative variables that are evaluated for FTA in liver transplant surgeries include body mass index (BMI), Child-Turcotte-Pugh (CTP) score, model for end-stage liver disease (MELD) score, serum creatinine, and prothrombin time. Duration of surgery is another important variable for deciding on FTA. Some experts follow the safe operating room extubation after liver transplant (SORELT) criteria to assess the feasibility of FTA after liver transplant. It has been reported that in patients undergoing a liver transplant, young age, low BMI, CTP class A or B, low MELD score, metabolic equivalent (MET) score of 4–6, and absence of significant co-morbidities can be considered favourable preoperative criteria for FTA. The intraoperative criteria predictive of successful FTA in liver transplant surgeries include transfusion of <5 units of packed red blood cells, low inotropic requirement at the end of surgery, short duration of surgery, and low-risk vascular anastomoses.[12,13]

3. Outcomes, Benefits, and Safety of FTA

According to experts in both cardiac and transplant anaesthesia, early extubation facilitates early recovery and decreases the ICU and hospital LOS, besides leading to better cardiac stability, achieving faster patient ambulation, and reducing the risk of hospital-acquired infection. In liver transplant, ventilation leads to increase in intra-thoracic pressure leading to rise in central venous pressure, which can affect the outflow from the newly grafted liver. Spontaneous breathing improves the outflow from the graft leading to quicker recovery of the liver function test.

Additionally, the cost benefits of FTA due to reduced LOS in the ICU and fewer monitoring tests due to early hospital discharge have been previously reported.[7,14] In a study evaluating the short- and long-term benefits of FTCA in patients undergoing CABG, improvement in post-extubation intrapulmonary shunt fraction and a reduction in ICU and hospital LOS were reported in the short-term, while in the long term, decreased resource use was seen for a 1-year period after the index hospitalization.[15] In contrast, prolonged intubation was reported to be highly associated with mortality. Liver transplant patients who were extubated early had not only a lower LOS in the ICU and earlier discharge from hospital but also a lower rate of postoperative complications and a significant decrease in the cost of care. Most notable were the fewer cases of pulmonary infection and sedation-delirium associated with postoperative ventilation.[16,17]

4. Anaesthesia Agents and Monitoring Protocol for FTA

Typically, FTA involves the administration of short-acting agents at minimal doses. Induction is done with intravenous (IV) fentanyl, propofol/sevoflurane and a neuromuscular blocker (NMB). Volatile agents (e.g., sevoflurane or desflurane) are used for maintenance. However, in patients at very high risk of postoperative nausea and vomiting, total IV anaesthesia might be used instead of inhalation agents.[18] Ideally, an anaesthetic agent used for FTA should have a rapid onset and offset effect, simple metabolism, ability to diminish the surgical stress response, facilitate recovery, improve postoperative outcomes, and decrease the incidence of postoperative adverse events with minimal side-effects.[19] The less-soluble volatile anaesthetics, desflurane (3%–6%) and sevoflurane (0.75%–1.5%), are better than propofol and isoflurane for maintaining anaesthesia as well as early recovery.[20]

Most cardiac anaesthesia expert who were on this panel follow the ERAS recommendations for the FTCA protocol. Opioids are used at minimal doses, and reversal agents are optimally used to facilitate uneventful recovery. They routinely use either sevoflurane or desflurane with no preference for one over the other. Studies have shown

the potential benefits of volatile anaesthetics over IV agents in cardiac surgery.[21] Although IV opioids at higher doses maintain intraoperative hemodynamic stability with good postoperative analgesia, they can lead to delayed extubation. Smaller doses of opioids combined with volatile anaesthetics allow earlier extubation, although the postoperative pain might be higher.[22] A meta-analysis showed that desflurane and sevoflurane reduce postoperative mortality and the incidence of myocardial infarction.[23]

The transplant anaesthesia expert panellists do not routinely follow rapid sequence induction except in emergency surgery or for patients with ascites. Inhalation agents are routinely used, and among them, sevoflurane and desflurane are preferred since they are short-acting. Due to the possibility of obtunding of hepatic artery buffer response, isoflurane or desflurane is preferred, especially in liver transplant surgery.[24] Aldrete scoring is routinely used to assess patients undergoing FTA before shifting them from the post-anaesthesia care unit (PACU) to the ward. While volatile anaesthetics can decrease mean arterial pressure and portal blood flow, desflurane and sevoflurane have little effect on total hepatic blood flow and are hence preferred in FTA.[25] Dose requirements for both desflurane and isoflurane decrease during the anhepatic phase, and MELD scores are inversely proportional to the dose of volatile agent required.[14] In transplant surgeries other than the liver, volatile anaesthetics used for anaesthetic maintenance are associated with better outcomes than IV anaesthetics.[26]

5. Role of Neuromuscular Blockers in FTA and Reversal Agents used

Among the cardiac anaesthesia experts, cisatracurium and rocuronium are the preferred neuromuscular blockers (NMBs) for FTCA. According to them, NMBs have a better effect if used in small boluses in FTCA than by infusion. Moreover, volatile anaesthetics further increase the potency of NMBs. However, hypothermia prolongs the action of NMBs; hence, patients need to be kept warm to facilitate successful FTCA. According to the experts, since cisatracurium has a relatively shorter duration of action, many patients might not require reversal and reversal agents are used on a case-to-case basis. Studies have shown that body temperature <36ºC is a significant risk factor for residual neuromuscular block after surgery. Prevention of hypothermia and use of a nerve stimulator to assess the degree of the block during the procedure and to detect residual paralysis during recovery from anaesthesia are recommended.[27] Using the smallest dose of an NMB and avoiding the use of long-acting NMBs can prevent residual paralysis.[18]

The transplant anaesthesia experts who were in this panel also prefer cisatracurium or atracurium as the NMB of choice for FTA. They prefer cisatracurium due to its short duration of action, rapid reversibility, and the possibility of less hemodynamic fluctuations during extubation, and consider it as an ideal NMB. According to them, most patients administered cistracurium do not require reversal, and reversal agents are used if extubation is considered on the operating table. However, the use of cisatracurium in patients with hypothermia is associated with delayed elimination. In the experience of the transplant anaesthesia experts, no specific monitoring is required when using NMBs, except in patients with obesity, low ejection fraction, or reactive airway disease. Cisatracurium is preferred even in these high-risk patients. Moreover, experts have rarely observed residual paralysis during FTA. Among volatile anaesthetics used with NMBs, transplant anaesthesia experts preferred sevoflurane for both liver and renal transplants. It has been reported that delayed and primary graft nonfunction might result in a prolonged neuromuscular block. Neuromuscular monitoring is critical in these situations to ensure adequate muscle strength before extubation.[14] Inadequate neuromuscular recovery can depress the pharyngeal muscle tone. Neuromuscular monitoring can diagnose neuromuscular blocks and minimize peri-operative complications in patients undergoing liver transplantation.[5]

6. Contraindications for FTA and Factors Leading to Delayed Extubation

According to the cardiac anaesthesia experts, contraindications for FTCA include low ejection fraction, left ventricular dysfunction, valvular diseases, arrhythmias, pulmonary complications, and hypothermia. A study among 5367 patients who underwent cardiac surgeries under FTCA reported that advanced age and left ventricular ejection fraction <35% were significant predictors of FTCA failure.28Another study among patients aged >70 years reported that stroke, renal failure, and procedures other than primary isolated CABG were independent predictors for failure of FTCA. In patients aged >80 years, congestive heart failure was an additional independent risk factor for FTCA failure.[28] Constantinides et al. in a study among 1084 patients undergoing cardiac surgery reported that impaired left ventricular function with or without recent acute coronary syndrome, re-do operation, extracardiac arteriopathy, preoperative intra-aortic balloon pump, raised serum creatinine, and nonelective and complex surgery were independent predictors for FTCA failure.[29] Preoperative risk calculators such as the EuroSCORE, ASA class >3, New York Heart Association (NHYA) class >3, and total operation time >267 min are strong predictors of fast-track failure.[30]

According to the transplant anaesthesia, patients with low ejection fraction, significant blood transfusions on the table, hypothermic patients, and patients with ongoing bleeding, high requirement for inotropes, and low urine output were not favourable candidates for FTA. Studies have

shown that the requirement of more than 6 units of packed red blood cells, kidney and pulmonary dysfunction, higher grades of encephalopathy, CTP class C, acute liver failure, retransplantation, and obesity were predictors of delayed extubation in patients undergoing a liver transplant.[7,14]

7. FTA in Paediatrics

According to the cardiac anaesthesia experts, uncomplicated paediatric cardiac surgeries can be considered for FTCA; however, caution is necessary. Based on the literature available, the panel thought that paediatric FTCA is less commonly used in India than in the US and Europe. A survey conducted by the European Association of Cardiothoracic Anesthesiologists among 144 paediatric cardiac surgical centres in 29 countries revealed that 76% of the paediatric cardiac anaesthesiologists reportedly practised UFTA, with 50% of them also performing UFTA in on-pump cardiac surgeries, although the proportion was highly variable; moreover, 77% of them decided on UFTA on a case-to-case basis.10 Another study in which UFTA was used in children with congenital heart disease and low birth weight with ASA physical status III and IV reported that the extubation time and ICU and hospital LOS were significantly shorter in the UFTA group versus FTCA group ($P < 0.05$) and no serious hemodynamic changes or serious complications were observed.[2] UFTA in children facilitates the rapid resumption of normal physiologic conditions, early feeding, interaction with parents, decreased incidence of ventilator-associated complications,[31] and lower morbidity.[32]

8. Current Practice of FTA in India

The experts in cardiac anaesthesia opined that they extubate early by default unless there are contraindications for FTCA. There have been recent studies published from India on the outcomes of FTCA in various patient subgroups. In a study among patients who underwent valve replacement surgery, the FTCA group had a significantly shorter median time to extubation (4.30 h vs 18.14 h), reduced ICU stay (40.85 h vs 64.25 hrs), shorter duration of inotropic support postoperatively (12 h vs 30 h), and shorter hospital LOS (6.28 days vs 8.41 days) than the non-FTCA group.[33] Another study compared immediate extubation vs UFTA (extubation within 2 h) among patients undergoing off-pump CABG. Immediate extubation was found to be safe as no patient required reintubation or had respiratory insufficiency. None of the patients in either group had major postoperative complications. Though the ICU stay was similar in both groups, the hospital LOS was 5.66 days in the immediate extubation group and 6.36 days in the UFTA group ($P = 0.001$). However, time spent in the operating room at the end of surgery was 14.03 min and 33.9 min in the UFTA group and immediate extubation groups, respectively.[34] In a rural tertiary care centre, UFTA was used in a cohort of 40 patients comprising diverse age groups, including infants and elderly patients. Extubation could be achieved within 30 min in 72.5% of patients with a mean ICU LOS of 39 h, 55% of patients were ambulated on postoperative day 1, and UFTA led to approximate cost savings of 5000 rupees/patient/day.[35]

According to the experts in transplant anaesthesia, FTA in transplant surgeries in India has evolved over a period of time. ERAS criteria are usually adhered to. However, it is not practically feasible to adopt all parameters consistently. Majority of the renal transplant patients (up to 99% in some centres) get extubated early. In a liver transplant, patients are evaluated for feasibility of FTA preoperatively, and some centres have progressed to bypassing the ICU. FTA is feasible in about 30%-40% of patients undergoing heart and lung transplants. Even in other major surgeries the concept of FTA is well-established, and efforts are made to extubate patients at the earliest. A case series of 15 patients who underwent a liver transplant in a tertiary care centre in India reported a 90% success rate with on-table extubation. Those with successful FTA were young, had a low BMI, most had CTP class A or B, low MELD score, a MET score of 4–6, no significant co-morbidities, and no need for a major blood transfusion.12 However, there are no other studies of FTA in transplant from India.

9. The Future of FTA

Multidisciplinary collaboration is necessary to establish FTA protocols in hospitals and ensure their success. Surgeons, anaesthesiologists, nurses, physiotherapists, nutritionists, and the patients and their families need to be part of the multidisciplinary team.[19,36] Some centres use a PACU-centric model, whereby suitable patients are pre-identified to bypass the ICU.[5] It has been reported that treatment in a specialised PACU rather than an ICU after elective cardiac surgery leads to earlier extubation and quicker discharge to a step-down unit, without compromising patient safety.[37] However, according to the Indian cardiac and transplant anaesthesia experts, though PACU is a valuable concept, currently no major centres in India have introduced it.

10. Conclusion

For the increased acceptance of FTA, it is important to adopt a consensus-based standardised protocol for perioperative care. Precise preoperative screening and patient selection are critical. In addition, careful monitoring within the first 24 h postoperatively and the availability of a multidisciplinary team are essential for a wider adoption of FTA in India.

11. Author Contributions

Both authors made substantial contribution to the conception and design of the advisory board meetings, documented the discussions, and substantively reviewed and approved the final manuscript for submission.

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13. Data Availability Statement

Not applicable as this is a review article.

14. Conflicts of Interest

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