Comparison of fast-track anesthesia and conventional cardiac anesthesia for valve replacement cardiac surgery

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ABSTRACT

Background: Fast-track anesthesia has gained widespread use in cardiac centers around the world mainly for coronary artery bypass surgeries. However, only few studies have focused on fast-track anesthesia after valve surgeries. This study examines the feasibility and hemodynamic stability of fast-track anesthesia after valve surgeries.

Methodology: The study was designed as a retrospective observational study. A total of 367 patients who underwent valve replacement surgery between January 2006 and November 2015 were included in this study. Conventional cardiac anesthesia (CCA) technique was followed initially from January 2006 to May 2010 while fast-track anesthesia protocol (FTA) was implemented from August 2010 onwards till November 2015. The objectives were to compare the duration of ventilation, the incidence of re-intubation and postoperative pneumonia, incidence of low cardiac output syndrome, mortality and postoperative length of stay in the ICU, intermediate care unit and the hospital.

Results: The CCA group comprised of 140 patients and the FTA group had 227 patients. There was a significantly shorter median time to extubation (4.30 hrs vs. 18.14 hrs), and reduced intensive care unit stay (40.85 hrs vs. 64.25 hrs) in FTA group. Patients in FTA group required inotropic support only for 12 hours in the immediate postoperative period, whereas CCA group required inotropic drugs for almost 30 hours. One patient in FTA group had pneumonia compared to 5 in CCA group. Two patients in FTA group required re-intubation for re-exploration. The fast-track group had significantly decreased median length of hospital stay (6.28 vs 8.41 days).

Conclusion: This study shows that fast-track anesthesia protocol can be applied safely to patients undergoing cardiac surgery other than coronary artery bypass grafting. Fast-tracking not only reduces ventilation time but also reduces hospital stay, with acceptable morbidity and mortality.

Key words: Anesthesia; Anesthesia Recovery Period; Endotracheal Anesthesia; Anesthesia, General; Fast-track Cardiac Anesthesia; Intermittent Positive-Pressure Ventilation; One-Lung Ventilation; Mechanical Ventilation; Heart Valve Prosthesis Implantation; surgeries; Cardiac Surgical Procedures; Cardiac Surgery

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INTRODUCTION

Fast-track recovery protocols (FTRPs) are a sequence of applications aimed at early extubation (6-8 hours after the operation) and early discharge from the intensive care unit (ICU) (before 24 hours) and from the hospital (on postoperative day 5). This process is intended to ensure that the patient returns to his normal activities as early as possible without endangering patient-safety and compromising the quality of care.¹² This is being increasingly achieved by the use of management protocols involving early extubation, early removal of chest drains and early
discharge from hospital with close follow-up. Many studies have addressed the issue of early extubation and have shown that postoperative ventilation times can be reduced without increasing the risk to the patient.3–5 Recent advances in anesthesia, surgery, myocardial protection, hemodynamic monitoring, and postoperative analgesia have indeed reduced the need to ventilate patients postoperatively. Fast-track anesthesia (FTA) has gained widespread use in cardiac centers around the world, mainly for coronary artery bypass surgery. Immediate extubation after coronary artery bypass grafting with or without extra-corporeal circulation has been described.6-8 Very few studies describe the use of FTA in valve replacement surgeries. This study was conducted to compare the risks and benefits of FTA compared to conventional cardiac anesthesia (CCA) in peri-operative care of valve replacement surgeries.

METHODOLOGY
This study was designed as a retrospective study. It, being an audit of retrospective data, the institutional research committee waived off the need for a formal ethics committee approval. Consecutive patients who underwent elective cardiac surgeries at Pondicherry Institute of Medical Sciences, Pondicherry, were included in the study. Emergency surgeries, patients with renal dysfunction, history of cerebro-vascular accidents, tricuspid valve repairs, valvular disease with supra-systemic pulmonary hypertensive patients and severe systolic dysfunction were excluded from the study. During the first half of the study period (January 2006 until May 2010), 140 patients received CCA. 227 Patients undergoing surgery from August 2010 to November 2015 comprised the second group of patients receiving FTA.

As our standard protocol for the cardiac surgery patients, all patients were explained about the details of the surgical procedure, anticipated problems and the methods to achieve early ambulation. They were explained/trained to use an incentive spirometer well before surgery. Standard premedication included tab diazepam 0.1 mg/kg orally on the night before surgery and at 6 AM on the morning of surgery.

All patients were induced with inj midazolam (0.05 µg/kg), fentanyl, a titrated dose of thiopentone sodium and vecuronium (0.1 mg/kg). Except fentanyl, the doses of other drugs used for induction were similar in both the groups. The dose of fentanyl was 10-15 µg/kg in CCA group and 5 µg/kg in FTA group. Maintenance of anesthesia consisted of 1% isoflurane in a 50:50 oxygen/air mixture, vecuronium intermittent boluses and fentanyl 2 µg/kg hourly bolus, throughout the surgery in both the groups. Mechanical ventilation in CCA group was with volume control modes (minute ventilation breaker), while in FTA group we followed open lung ventilation strategy (OLV) which included synchronized intermittent mechanical ventilation with low tidal volumes of 6 ml/kg and PEEP 7 mmHg till the patient was extubated.

Cardio-pulmonary bypass (CPB) protocol: Maintenance of anesthesia was continued during CPB with the volatile agent delivered through the CPB circuit in both the groups. CPB protocol was same in both the groups. An open CPB system with arterial filter (40 µ) was used. Heparinization of the patient was performed with 300 IU/kg body weight of unfractionated heparin to achieve an activated clotting time (ACT) of > 400 sec (normal range 180 to 240 sec). CPB was performed with mild hypothermia (nasopharyngeal temperature: 32–34 °C). Perfusion pressure was maintained between 50 - 60 mmHg. Meticulous myocardial protection during CPB is a necessary pre-requisite for stable myocardial function after CPB. In particular, we achieved this with intermittent antegrade and retrograde cardioplegia, delivering 500 ml of normothermic blood cardioplegic solution. Active re-warming was started while approaching termination of CPB. Once CPB was terminated and hemostasis was secured, heparin reversal was attained with protamine to achieve an ACT of around 120 sec.

At the conclusion of surgery, patients were shifted and ventilated in the ICU. In CCA group, sedation was maintained by infusion of fentanyl 2 µg/kg/hr. Patients were actively rewarmed with forced warm air using disposable blankets. Mechanical ventilator modes were synchronized intermittent mandatory ventilation plus pressure support with a respiratory rate of 12/min, a tidal volume of 8 to 10 ml/kg, a fractional inspired oxygen concentration (FiO₂) of 0.4, a positive end-expiratory pressure of 3 to 5 mmHg, a pressure support of 15 mmHg, and a trigger sensitivity of –2 cmH₂O. Necessary modifications were applied on evaluation of routine arterial blood gas analyses.

Next day morning, once hemodynamic stability was achieved and absence of bleeding was confirmed, sedation was discontinued and the patients were assessed for extubation.
In FTA group, the patients were shifted and ventilated in ICU. Inj paracetamol 1 gm IV over 10 min, inj tramadol 1 mg/kg IV and buprenorphine skin patch were used for analgesia. After one hour these patients were assessed for extubation using the following criteria.

(a) Peripheral re-warming to normothermia
(b) Adequate cardiac output (adequate urine output and blood pressure, with stable rhythm without tachycardia)
(c) Acceptable drainage from chest and mediastinal drains
(d) Chest radiogram and arterial blood gases within normal limits

Once the above mentioned criteria were fulfilled, residual muscle paralysis was reversed with neostigmine and glycopyrrolate and ventilation started with pressure support of 15 mmHg + PEEP 5 mmHg for 30 min. They were extubated once they were conscious, hemodynamically stable, with a PCO2 < 45 mmHg, pH > 7.30, PO2/FiO2 ratio > 250, with no sign of postoperative hemorrhage, receiving dopamine < 5 μg/kg/min and/or noradrenaline < 0.05 μg/kg/min.

On postoperative day 1, chest drains were removed provided there was no significant drainage. If rhythm was stable with satisfactory heart rate and BP without any inotropic support, patients were shifted to postoperative ward. All patients were encouraged early ambulation and intense chest physiotherapy. Patients were discharged when they were hemodynamically stable, had a normal chest x-ray, stable rhythm, healthy wound and had accepted oral medications.

RESULTS

The CCA group comprised of 140 patients and the FTA Group 227 patients. Baseline characteristics of the two groups are presented in Table 1. There were no significant differences between the two groups in age and gender (Table 1).

Types of valvular surgery in either group were comparable as shown in Table 2.

There was no significant difference between CPB time and cross-clamping time among both the groups (Table 3).

However, there was a statistically significantly shorter median time to extubation (4.3 hrs vs. 18.14 hrs), ICU stay (40.85 hours vs. 64.25 hours) and postoperative stay (6.28 days vs. 8.41 days) in FTA

Table 1: Frequency and sex distribution of the study groups: data given as N (%)

<table>
<thead>
<tr>
<th>Type</th>
<th>Male</th>
<th>Female</th>
<th>Average age (yrs)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCA</td>
<td>61 (43.6)</td>
<td>79 (55.3)</td>
<td>27.8</td>
<td>140</td>
</tr>
<tr>
<td>FTA</td>
<td>107 (46.1)</td>
<td>120 (53.8)</td>
<td>29.1</td>
<td>227</td>
</tr>
</tbody>
</table>

Table 2: Comparative frequency of procedures in two groups; data given as N (%)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>CCA</th>
<th>FTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVR</td>
<td>13 (8.7)</td>
<td>40 (19.2)</td>
</tr>
<tr>
<td>DVR</td>
<td>45 (31.2)</td>
<td>59 (28.5)</td>
</tr>
<tr>
<td>MVR</td>
<td>82 (58.3)</td>
<td>128 (50.8)</td>
</tr>
</tbody>
</table>

Key: AVR – Aortic valve replacement; DVR – Double valve replacement; MVR – Mitral valve replacement

Table 3: Comparison of bypass and cross-clamp times in two groups (Mean ± SD)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CCA</th>
<th>FTA</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bypass time; MVR/AVR (mins)</td>
<td>75.42 ± 5.92</td>
<td>75.87 ± 5.02</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Bypass time; DVR (mins)</td>
<td>122.71 ± 12.09</td>
<td>120.80 ± 12.14</td>
<td></td>
</tr>
<tr>
<td>Cross-clamp time; MVR/AVR (mins)</td>
<td>57.42 ± 10.92</td>
<td>61.87 ± 10.02</td>
<td></td>
</tr>
<tr>
<td>Cross-clamp time; DVR (mins)</td>
<td>100.71 ± 10.09</td>
<td>100.80 ± 10.14</td>
<td></td>
</tr>
</tbody>
</table>

Key: AVR – Aortic valve replacement; DVR – Double valve replacement; MVR – Mitral valve replacement

Table 4: Mechanical ventilation time, ICU stay and postoperative stay in the two groups

<table>
<thead>
<tr>
<th>Parameter</th>
<th>FTA</th>
<th>CCA</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical ventilation (hrs)</td>
<td>4.3 (±0.29)</td>
<td>18.14 (± 1.15)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>ICU stay (hrs)</td>
<td>40.85 (0.15)</td>
<td>64.25 (0.77)</td>
<td></td>
</tr>
<tr>
<td>Postoperative stay (days)</td>
<td>6.28 (0.072)</td>
<td>8.41 (0.18)</td>
<td></td>
</tr>
</tbody>
</table>

Patients in FTA group required inotropic support with dopamine (5 μg/kg/min) and noradrenaline (0.05 μg/kg/min) only for 12 hours in the immediate post op period, whereas CCA group required dopamine (5 μg/kg/min) and noradrenaline (0.05 μg/kg/min) for almost 30 hours (p < 0.05).
fast-track vs. conventional cardiac anesthesia

group when compared to CCA group (p < 0.001) (Table 4). Two patients in FTA group could not be extubated early as they required re-exploration.

About complications, two patients in FTA group required re-intubation for re-exploration, two patients in either group expired on second postoperative day. Three patients in CCA and 2 in FTA needed prolonged ventilation due to postop neurological sequelae. Only one patient in FTA group had pneumonia compared to five in CCA group. Mortality was similar in both the groups (2 in each group). Discharge to 30 days mortality was nil in either group.

DISCUSSION
	Till late nineties, cardiac surgeries involved the use of high dose of opioid agents and prolonged postoperative elective mechanical ventilation which in turn led to prolonged ICU stay and a protracted recovery. Fast-track anesthesia for cardiac surgeries was introduced during early nineties with the advent of new surgical techniques, warm by-pass and short acting anesthetic drugs. Fast-track anesthesia involves early extubation after cardiac surgeries, leading to early mobilization and rehabilitation of these patients. Early extubation is known to improve cardiac performance due to increased ventricular filling and reduces the incidence of postoperative pulmonary complications such as atelectasis and pneumonia. Early mobilization has shown to improve patients’ psychological well-being. Fast-tracking is also known to shorten ICU and effective hospital stay resulting in reduction of cost and better fund utilization.

Postoperative pulmonary dysfunction (PPD) is a frequent and significant complication after cardiac surgery. Many factors have been described to contribute to this inflammatory response, including surgical procedure with sternotomy incision, effects of general anesthesia, topical cooling, extracorporeal circulation (ECC) and mechanical ventilation (VM). Certain factors cannot be altered like general anesthesia, sternotomy incision and ECC. However, morbidity and mortality can be significantly reduced if we adopt protective ventilation strategy like ‘Open Lung Approach’ (OLA), CPAP during ECC, maintaining normothermic perfusion and early extubation and noninvasive mechanical ventilation postoperatively. In our study we followed OLA technique, normothermia and early extubation without compromising the patient safety. We found significantly shorter mechanical ventilation time and length of stay in the ICU in fast-track group. Haanschoten et al retrospectively analyzed 4,510 patients who underwent AVR, CAGB or CAGB + AVR, and they found that fast-track is a safe procedure for cardiac surgery; however, age and left ventricular dysfunction are significant preoperative risk factors which resulted in failure of fast-track protocol. Ashok Kandasamy et al retrospectively analyzed 120 patients who underwent valve replacement procedure and concluded that early extubation is feasible and offers added advantage in terms of accelerated recovery, shorter ICU stay with no significant difference in postoperative patient outcome.

Early extubation after cardiac surgery is a welcome step, as the incidence of pulmonary complications decreases significantly. However, during initial stages, the incidence of re-intubation was high with its added set of complications. The incidence of re-intubation in the FT method ranges from 1% to 7%. In our study, two patients (1%) required re-intubation in the FT group. Cheng et al re-intubated one patient (2%) in their FT group, Wong studied 88514 patients and reported re-intubation with an incidence of 1.6%. In addition, there was no difference in arterial blood gas indices between the two groups in time intervals before and after tracheal extubation, which emphasizes the safety of early extubation. The chances of reintubation will be increased if the patients are hemodynamically unstable, cold, hypovolemic, or require considerable opiate medication. Hence it is of utmost importance to have a stable, warm, normovolemic and awake patient with good analgesia at the completion of operation.

Previously, postoperative cardiac surgical care involved prolonged periods of sedation and ventilation, and as a result, prolonged ICU stay. Numerous studies have proved that there is no benefit in prolonged sedation and ventilation, and it may be detrimental with increased rates of pneumonia and ventilator-related complications. This is supported by our finding that the CCA group had a significantly greater proportion of patients developing postoperative pneumonia (p = 0.001) compared to FTA group. In addition, we found a decreased requirement of inotrope supplementation and decreased rate of postoperative low cardiac output syndrome in fast-track group compared to conventional cardiac anesthesia group.

CONCLUSION
	Early extubation in valve surgery is feasible
and offers a substantial advantage in terms of rapid recovery, shorter ICU and hospital stay. It also reduces complications like postoperative pneumonia and low cardiac output syndrome. We believe that some of the practices we introduced in the care of these patients might have contributed towards rapid recovery and early discharge from the hospital. These factors are; pre-operative training in incentive spirometry, normothermic CPB, standardized surgical procedures, open lung approach (OLA), short / ultra-short acting anesthetic/analgesic agents, full rewarming and maintaining normothermia, early extubation, early ambulation and intense physiotherapy. Hence, we conclude that fast-track cardiac anesthesia protocol in valve replacement surgery is safe and does not increase perioperative morbidity.

**Conflict of interest:** None declared by the author.

**Author contribution:** Both of the authors contributed in concept and conduct of the study, the literature search, data analysis and manuscript preparation, and accepts full responsibility for the material presented.

**REFERENCES**


