

## Perioperative Anaesthesia Management During Minimally Invasive Surgery in Patients with Aortic Valve Diseases

Research Article

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### Abstract

**Objective:** Minimally invasive aortic valve replacement is a common procedure in practice. Our aim is to present our experiences on our anaesthesia applications during these operations.

**Methods:** Upon the approval of the Hospital Ethics Committee, data of the patients that underwent minimal invasive aortic valve surgery between 1 January 2017 and 31 August 2017 were analysed retrospectively. Recorded details were age, gender, Body Mass Index (BMI), American Society of Anesthesiologists (ASA) classification, New York Heart Association classification (NYHA), Ejection Fraction (EF), Euroscore II, smoking history, accompanying diseases, cardiopulmonary bypass duration, aortic cross-clamping time, presence or absence of ventricular fibrillation, number of blood products given, time spent in intensive care unit, hospital stay, and intensive care mortality.

**Results:** Results from a total of 22 patients were analysed. Median value for age was 55, minimum was 36, and maximum was 83. Of the patients, 59% was female, while 41% was male. It was found that 68% of the patients were classified as NYHA II and 32% fell into NYHA III. Euroscore II percentage was established as median 1.73 (minimum 0.79-maximum 2.75). Median cardiopulmonary bypass time was 120 minutes (minimum 73 minutes-maximum 165 minutes), and median cross-clamp time was 95 minutes (minimum 47 minutes-maximum 127 minutes). Median length of stay in intensive care unit was 15 hours (minimum 8 hours-maximum 23 hours), median hospitalization duration was established as 5 days (minimum 3 days-maximum 9 days).

**Conclusion:** Anaesthesia applications in minimally invasive surgery carried out for aortic valve diseases predominantly include preoperative preparation, perioperative monitoring, and postoperative pain management.

**Keywords:** Aortic Stenosis; Aortic Valve Replacement; Minimally Invasive Surgery; Anaesthesia.

### Introduction

Aortic valve diseases can cause dyspnoea, palpitations, syncope and anginal symptoms, and it can also lead to significant low cardiac output and sudden death. In aortic stenosis, progressive left ventricular outflow tract obstruction increases left ventricular systolic pressure. While increased left ventricular systolic pressure raises myocardial oxygen requirement, it also decreases oxygen delivery and causes subendocardial ischemia. In such patients, compensatory left ventricular hypertrophy develops, and this causes diastolic dysfunction and pulmonary congestion. Aortic valve diseases may require conventional or minimal invasive surgical methods along with repair or replacement in addition to medical treatment. While conventional median sternotomy provides a good surgical

exposure, serious complications such as mediastinitis can effect directly to the surgery. Compared to classic median sternotomy, aortic valve replacement via right anterior mini-thoracotomy bears such advantages as the preservation of anatomical integrity, less bleeding and lower transfusion requirement, decreased stress response to surgery, lower respiratory complications, lowered complications of wound healing, provision of faster recovery, and related shortened hospital stays [2-9]. Minimal invasive heart surgery requires a unique anaesthesia method. It is important to establish functional deterioration due to aortic valve disease and accompanying comorbid conditions, and if possible, to apply treatments that would provide their relief during preoperative preparations. During anaesthesia induction and maintenance, monitoring and application of anaesthetic agents and other drugs

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and replacement therapies in order to preserve the haemodynamic stability require patient-specific attention. Single-lung ventilation can be implemented in order to increase surgical view. Shunt-increasing effects of anaesthetic agents can be observed during one-lung ventilation. Desflurane blood-gas partition is a low coefficient inhalation anaesthetic. It was shown to provide both early recovery and early discharge [10-12].

It is important to protect myocardium which has been hypertrophied and dilated during cardiopulmonary bypass. For this reason, a suitable cardioplegia method should be selected. Del Nido cardioplegia solution is a cheap method that does not contain glucose and calcium and that is mostly used as a single dose [13]. Postoperative pain characteristics are different in median sternotomy and anterior mini-thoracotomy, and various treatment approaches may be required [14-16].

In literature there are few studies which is about perioperative anaesthesia management during minimally invasive aortic valve surgery. Anaesthesiologists have a vital role in such a possibly complicated patient group. Our aim is to share our experiences on this issue and to review other studies published in the field.

## Methods

This study was conducted at a tertiary care hospital upon the approval of the Hospital Ethics Committee. Patients who underwent aortic valve replacement via right anterior mini-thoracotomy in the Cardiovascular Surgery Clinic between 1 January 2017 and 31 August 2017 were included in the study. Exclusion criteria were patients below the age of 18, patients who underwent median sternotomy, and patients without available records. Data of the patients included in the study were analysed retrospectively from the hospital's electronic medical records system. Age, gender, BMI, ASA and NYHA classifications, EF, Euroscore II, smoking history, accompanying diseases, cardiopulmonary bypass time, cross-clamp time, presence of ventricular fibrillation, number of blood products received, intensive care unit length of stay, hospital stay, and intensive care unit mortality were recorded.

As premedication, all patients were given 5mg diazepam 8 hours before the operation orally. Thirty minutes before the surgery, 0.1mg/kg morphine was administered intramuscularly. Patient taken to the operation room underwent, six-channel ECG, pulse oximetry, invasive arterial blood pressure, central venous pressure measurement through jugular central vein catheterisation, bispectral index, and Near-Infrared Spectroscopy (NIRS). External defibrillator pads were appropriately placed on the back of patients. Following the anaesthesia induction with 0.04mg/kg midazolam, 10mcg/kg fentanyl, 1mg/kg propofol, and 0.5mg/kg rocuronium, endobronchial intubation was conducted with left double-lumen tube. Correct placement of double-lumen tube was provided with auscultation. Controlled ventilation was ensured in manner suitable for each patient so as to provide end-tidal carbon dioxide within normal limits. Anaesthesia was maintained with 2-6% desflurane, 50% oxygen and 50% air mix. Rocuronium and fentanyl were administered every 45 minutes as intravenous bolus. Through right internal jugular vein, central venous catheter and oral transoesophageal echocardiography (TEE) probe were placed. Patient was given 30 degree left lateral decubitus position. Following suitable surgical area cleaning and surgical covering, low-dose heparinisation was carried out. Femoral artery and vein

were cannulised. Using double-lumen tube, right lung ventilation was stopped and only the left lung ventilation was permitted. Right lung was deflated and right anterior mini-thoracotomy incision of 4-5cm was conducted. Heparinisation of 300 IU.kg<sup>-1</sup> dosage was carried out with activity clotting time being lower than 400 seconds. Cardiopulmonary bypass was conducted by using roller pump and with 2.4L.m<sup>-2</sup>.min<sup>-1</sup> non-pulsatile current. During cardiopulmonary bypass, systemic hypothermia was maintained at 30-32°C. After aortic cross-clamp was placed, cardiac arrest was conducted Del Nido cardioplegia solution was administered via antegrade approach for the myocardial protection. Following the replacement of prosthetic valve, deairing was done with the help of TEE. Patient temperatures were increased to 37°C after the removal of cross-clamp. Patients who developed ventricular fibrillation were defibrillated with the help of external pads. After establishing haemodynamic stability, patients were separated from cardiopulmonary bypass. Protamine was administered after decanulation. When surgical procedure was completed, double-lumen tube and TEE probe were removed. Patient was then intubated with single-lumen endotracheal tube. In order to contribute to postoperative analgesia, 20 ml 0.25% bupivacaine was injected in the wound site and its periphery in thoracotomy site. Following surgery, patients were transferred to cardiopulmonary surgery intensive care unit in a motorised manner. During the post-operative period, multimodal analgesia was ensured with paracetamol, tramadol, and diclofenac.

## Statistical Analysis

All analyses were carried out by using SPSS (version 21.0) software. Categorical variables in patients were expressed by numbers and percentage. Whether the distribution of numerical data was normal or not was evaluated by histogram analysis. Results that did not manifest normal distribution were expressed by median value, minimum and maximum.

## Results

Aortic valve replacement via right anterior mini-thoracotomy was conducted on a total of 22 patients within eight months between 1 January 2017 and 31 August 2017. Table 1 shows demographic and clinical data of these patients. Median value of age was 55 with minimum being 36 and maximum 83. Of the patients, 59% were female and 41% were male. Functional status of 68% of patients were NYHA II and in 32% of them were in NYHA III. Euroscore II percentage was found as median 1.73 (minimum 0.79-maximum 2.75). Of the patients, 41% had smoking history. Among the accompanying diseases, the most common ones were established as hypertension (41%) and diabetes mellitus (41%).

Median cardiopulmonary bypass time was 120 minutes (minimum 73 minutes-maximum 165 minutes) and median cross-clamp time was 95 minutes (minimum 47 minutes-maximum 127 minutes). Ventricular fibrillation occurred in 27% of these patients. While median length of stay in intensive care unit was established as 15 hours (minimum 8 hours-maximum 23 hours), median hospitalization duration was 5 days (minimum 3 days-maximum 9 days) (Table 2). All patients were administered a total of 18 units of erythrocyte suspension and 20 units of fresh frozen plasma. Intensive care unit mortality rate of patients included in the study was 9%.

## Discussion

We found the intensive care unit mortality rate in patients that underwent aortic valve replacement via right anterior mini-thoracotomy as 2%. Minimal invasive techniques have become widespread in recent years in the field of surgery. Aortic valve replacement via right anterior mini-thoracotomy conducted in our country in a few centres fall into the category of minimal invasive procedures. Since minimal invasive heart surgery techniques are different from conventional techniques, there are certain issues that anaesthesiologists need to consider. In addition to clinical conditions of aortic valve patients being critical, anaesthesia and surgical operation bear additional risks.

Anaesthesiologists need to evaluate complaints, symptoms, and physical examination findings due to both aortic valve pathology and accompanying diseases of the patient by conducting preoperative patient visits. Single-lung ventilation provides a better surgical view in aortic valve replacement surgeries by right anterior mini-thoracotomy compared to double-lung ventilation. In an observational study conducted on 187 patients, Stolinski et al., compared the effects of single-lung and double-lung ventilations on respiratory functions during aortic valve replacement surgery by right anterior mini-thoracotomy. They observed that single-lung ventilation and double-lung ventilation did not pose significant differences in terms of respiratory functions [17]. A decision should be made for patients that are to undergo heart surgery by mini-thoracotomy on whether they would tolerate single-lung ventilation by analysing pulmonary function tests, arterial blood gas, and postero-anterior pulmonary roentgenography in the preoperative period [1, 14]. A prolonged single-lung ventilation

may not be maintained in patients with such pathologies as active bronchospasm or bullous lungs. Single-lung ventilation may cause an increase in the pulmonary artery pressure, decreased cardiac output, hypoxia and hypercarbia [18]. It is of utmost importance to bring the respiratory functions to the optimal level before operating on these patients. Of our patients that had severe chronic pulmonary disease received medical treatment in the preoperative period to recover respiratory functions by consulting chest disease specialists. Smoking should be quit as soon as possible. It bears importance to stop smoking at least two weeks before the surgery in order to decrease perioperative complications [14].

A low-dose oral benzodiazepine is recommended a night before the surgery as premedication in patients being prepared for minimal invasive open-heart surgery [14]. In addition, administration of intramuscular morphine half an hour before the operation would lead to patient being calmer and vital findings being stable [19].

In preoperative cardiovascular evaluation of patients with aortic valve disease, functional condition of the heart should be established through obtaining the history, physical examination, and invasive and non-invasive techniques. Among the non-invasive techniques are Holter ECG and echocardiography. Cardiac catheterisation is among invasive techniques. Severe aortic stenosis is known by mean pressure gradient being higher than 40 mmHg, and aortic valve site being under 1cm<sup>2</sup> or being symptomatic [20].

Perioperative monitoring bears utmost importance in terms of establishing cardiac complications in aortic valve operations. Use of TEE is quite beneficial in aortic valve surgery that utilises in-

**Table 1. Demographic and clinical data of patients.**

Age (Years)	55(36-83)
Sex (M/F)	9 (41%)/13(59%)
BMI	27.5(16.2-33.4)
ASA II/III	15(68%)/7(32%)
NYHA II/III	15(68%)/7(32%)
Ejection fraction (%), EF=30-50%/EF > 50%	10(45%)/12(55%)
Euroscore II (%)	1.73(0.79-2.75)
Smoking history	9(41%)
Accompanying diseases	Number (%)
Hypertension	9(41%)
Diabetes mellitus	9(41%)
Atrial fibrillation	2(9%)
Chronic Obstructive Pulmonary Disease	4(18%)
Chronic renal disease	1(5%)

Values are given as median (minimum-maximum) and in numbers (%).

**Table 2. Perioperative data of patients that underwent aortic valve replacement surgery by right anterior mini-thoracotomy.**

Cardiopulmonary bypass time (minutes)	120(73-165)
Cross-clamp time (minutes)	95(47-127)
Ventricular fibrillation	6(27%)
ICU length of stay (hours)	15(8-23)
Hospital stay (days)	5(3-9)
Transfused erythrocyte suspension (n)	18
Transfused fresh frozen plasma (n)	20
Intensive care unit mortality (n)	2(9%)

Values are given as median (minimum-maximum) and in numbers (%).

vasive techniques. Owing to TEE, removal of air also known as deairing is ensured in addition to the evaluation of myocardial ischemia, heart wall abnormalities, left ventricular diastolic functions, condition of volume, and catecholamine treatment [21-23]. Compared to other haemodynamic monitoring methods, the advantages of TEE include its ability to place and apply in a short time. However, it has such disadvantages as inability to provide constant monitoring, expensiveness, dependent on operator training, and the risk of gastrointestinal perforation [24, 25].

Pulmonary artery catheter may be utilised for cardiac surgery in patients with high risk that requires establishing cardiac output syndrome, pulmonary hypertension, and right and left ventricular dysfunction. However, it is not recommended for patients with low perioperative risk [26-30]. Such minimally invasive cardiac output measurement methods such as transpulmonary thermodilution and pulse contour analysis are alternatives to pulmonary artery catheterisation [31-33]. In minimally invasive cardiac surgery, further studies are needed to establish the results in patients that receive such haemodynamic measurement methods that are less invasive.

Following anaesthesia induction, anaesthesia can be maintained with volatile inhalation agents. Volatile inhalation agents were found to decrease postoperative troponin I levels in patients that undergo cardiac surgery [34-36]. Of the inhalation agents, desflurane was shown to provide a decrease in markers of myocardial necrosis and recovery of postoperative myocardial functions [37].

During aortic valve surgery, myocardial damage that may occur during aortic cross-clamp can be prevented by cardioplegia methods. Del Nido cardioplegia solution was suggested to increase tolerance against intracellular calcium increase that causes irreversible myocyte damage and to provide sufficient protection with a single dose through uniform distribution in myocardium [38-43]. When compared to other conventional cardioplegia methods in some studies, aortic cross-clamp time was found as shorter in patients that receive Del Nido cardioplegia [44, 45]. In contrast, in a study by Vistarini et al., Del Nido cardioplegia was shown not to shorten aortic cross-clamp time [46]. In our study, all patients were administered Del Nido cardioplegia. Both ease of application and uninterrupted surgery along with lower costs were ensured this way by administering only a single dose of cardioplegia. Minimally invasive surgery bears such advantages as less blood transfusion, better pulmonary functions, shorter hospital stays, and smaller skin scars from a cosmetic point of view compared to conventional heart surgery [47-55].

Postoperative pain management is quite important following heart surgery since pain causes tachycardia and hyperventilation. Occurrence of hypoxia during the period of heightened myocardial oxygen demand exacerbates the clinical picture of patient [14]. Multimodal analgesia is a recommended method in recent years for postoperative pain management. A well pain management ensures early mobilisation and fast recovery [56].

## Conclusion

In minimally invasive surgery conducted for aortic valve diseases, anaesthesiologists should carefully complete preoperative preparation. Technical equipment suitable for perioperative monitoring

should be used and anaesthesia applications should be specific to this operation should be carried out.

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